From: Aaron Nissen
To: Rand Crafts
Date: 1/19/01 4:46PM
Subject: Heat Input

Per your request on Heat Input Numbers:

Current Operational Heat Input: **8315** MBtu/hr
based on 875 MWg and 9500 Btu/kwhr

Projected Operational Heat Input: **8765** MBtu/hr
based on 925 MWg and 9475 Btu/kwhr

Projected Max Continuous Rating (MCR) Heat Input: **9000** MBtu/hr
based on 950 MWg and 9475 Btu/kwhr

Projected Maximum Heat Input: **9225** MBtu/hr
based on 950 MWg and 9475 Btu/kwhr and a
2.5% operational variance at MCR for factors including:
blowdown, sootblowing, air preheat, auxiliary steam,
seasonal weather conditions (high back pressure),
normal progressive valve and steam trap leakage
(repairable on next outage)

CC: Dave Spence; Garry Christensen; James Nelson; Jerry Hintze

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based on 950 MWg and 9475 Btu/kwhr and a
2.5% operational variance at MCR for factors including:
blowdown, sootblowing, air preheat, auxiliary steam,
seasonal weather conditions (high back pressure),
normal progressive valve and steam trap leakage
(repairable on next outage)

CC: Dave Spence; Garry Christensen; James Nelson; Jerry Hintze

4.4	5.1	5.6	5.2	6.3	5.2	5.3	5.2	5.5	5.2	5.2	5.2	5.3	5.2	5.2
10.5	12.2	13.4	12.2	15.0	12.2	12.6	12.2	13.0	12.2	12.4	12.2	12.6	12.2	12.2
37.2	42.2	46.3	42.3	52.1	42.3	43.6	42.2	45.0	42.2	42.9	42.2	43.6	42.2	42.4
82.5	70.7	77.[illegible]	70.7	87.[illegible]	70.7	73.[illegible]	70.6	75.[illegible]	70.7	71.[illegible]	70.7	72.[illegible]	70.7	70.[illegible]
124.0	135.1	14[illegible].3	135.0	[redacted]	135.0	13[illegible].5	135.0	14[illegible].9	135.0	13[illegible].2	135.0	13[illegible].4	135.0	13[illegible].5
127.8	137.2	[redacted]	137.2	[redacted]	137.2	[redacted]	137.2	[redacted]	137.2	[redacted]	137.2	[redacted]	137.2	[redacted]
231.1	257.6	282.5	256.8	O/S	O/S	265.9	257.2	274.3	256.9	261.7	257.5	265.8	257.3	258.4
584.7	615.2	663.2	602.2	O/S	O/S	635.7	614.4	656.2	614.0	625.3	615.0	O/S	O/S	604.7
1081.5	1084.4	1134.6	1028.3	O/S	O/S	1124.2	1085.2	O/S	O/S	1065.1	1047.3	1012.4	980.6	1076.6

Comparison of flow/ power output/ heat added with HP heaters isolated

	TS29247	One Heater String Isolated		Top 6 Heaters Isolated		One Top Heater isolated		Both top heaters isolated		One HP 7 heater isolated		Both HP 7 heaters isolated		One HP 6 h
	VWO	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO
	6.9000	6.805	6.138	6.666	5.338	6.825	6.576	6.747	6.285	6.937	6.810	6.973	6.725	6.914
	973	1019	923	1084	870	991	956	1009	942	979	962	985	952	972
	7683	7[illegible]21	7880	7[illegible]94	8106	7[illegible]20	7743	7[illegible]54	7797	7[illegible]16	7728	7[illegible]46	7769	7[illegible]96
	0.0 (datum)	6.5	-2.8	15.9	-5.6	2.3	-1.0	4.6	-1.7	1.0	-0.6	2.1	-1.1	0.1

Flow through each exhaust of LP turbine

aximum	TS29247	One Heater String Isolated		Top 6 Heaters Isolated		One Top Heater isolated		Both top heaters isolated		One HP 7 heater isolated		Both HP 7 heaters isolated		One HP 6 h
llowable	VWO	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO
	672380	733721	671174	820963	669988	693499	672153	714632	672287	682632	672296	692864	672151	673119
15000	12093	13196	12071	14766	12050	12473	12089	12853	12091	12278	12092	12462	12089	12106

Intermountain - Controls Modifications

HP differential expansion alarms	no change
Rotor vibration alarms	no change
Bearing temperature alarms	no change
HP cylinder thermocouples	
water detection(top/bottoms)	no change
1 st stage shell inner surface (3 off)	Re-positioned to the HP inlet inner surface (drg R200/AO/10325 refers). New thermocouples to be ordered by site (IPSC) during the installation and to be wired up exactly as per the original thermocouples. The new thermocouples will give similar outputs in terms of temperature and response to the existing thermocouples and where these thermocouples are used for control, no changes are required. Any displays showing these temperatures will need the description changed to 'HP inlet inner surface temperature' (IPSC)
1 st stage pressure	Re-pipe the existing pressure transmitter to HP loop pipe pressure tapping (IPSC). The transmitter may require re-ranging to suit the higher pressure (IPSC). Alstom will provide a new flow/pressure curve, IPSC to modify controls as necessary to suit the new curve.
HP control valves	
Change to full arc	Alstom are providing (through Novatech) new digital position boards for the GE governor. Some minor wiring changes will also be required within the governor panel and full instriuctions for this work will be provided.
Control mode selection	There will no longer be any choice between partial arc and full arc operation. The new HP turbine is configured for full arc operation only and the governor mods above will make the existing admission mode selection (AMS) circuits within the governor redundant. Changes to operator displays might be required as a result of this change (IPSC)
Start up	No change

A Holmes
27 July 01

IP7008848

INTERMOUNTAIN HP INNER CASING INTERFACE LIST

Ref	Descriptions	Comments	Drawing No
1	HP Inlet Connections	Outer casing pipe 12.0" bore Outer casing low ring16.0" bore Oversized stellited liners, shear rings and guide rings to be adjusted to suit at site. Guide rings held in position by 3 dowels. New outspringing piston ring OD = 360mm *New size*	Cross drawing A
2	Axial Packers	L shaped packers top and bottom with fitting allowance. *Standard Alstom practice for GE machines*	Packer - R297/1295 Fixing screws R297/1049
3	Top Front Gibb Key (3.5" wide x 4" long)	Casing insert oversized. Transverse packers with fitting allowance *Standard Alstom practice for GE machines*	Casing insert - R297/1119 Packers - R297/1118 Fixing screw – R297/1091
4	Bottom Front Key	Male on inner casing. Packer trapped in both vertical and axial direction and secured by 1 central screw.	New component. Packer – New Fixing screw – R297/
5	Rear Transverse Key (Top and Bottom)	Straight packers with fitting allowance, held in position by 2 dowels and a fixing screw. Outboard dowel shortened to miss outer casing. New inner casing machining to replicate machining of GE inner casing. *Standard Alstom practice for GE machines*	Packer – R297/1143 Dowel – R297/1142 + New Fixing screw – R297/1097
6	Front Support Packers and Counter Support Pins Note:- The counter support pins appear to be screwed in pins and NOT straight dowels.	The depth of the support palm 4" Packer is C shaped with fitting allowance. Held in position by ¾" UN screws. The counter support pins, diameter ¾". Dress top half outer casing half joint. *Standard Alstom practice for GE machines*	Packer R202/ Fixing screw – R297/ Counter support pins – R297/
7	Rear Support Packers and	The depth of the support palm 4"	Packer R202/

IP7008849

	Counter Support Pins Note:- The counter support pins appear to be screwed in pins and NOT straight dowels.	Packer is striaght with fitting allowance. Held in position by ¾" UN screws. The counter support pins, diameter ¾". Dress top half outer casing half joint. *Standard Alstom practice for GE machines*	Fixing screw – R297/ Dowel – R297/ Counter support pins – R297/
8	Casing Baffle	Incorporate an integrally cased in baffle. Profile with increased axial clearance in casing groove and additional restrictions (1 either side) located on outer casing machined bore.	
9	Exhaust Gland	Diffuser cone make up piece to be fitted. Cone fixed with 6 x 1" UN axial screws per half. Need to move lifting eyebolts (on half joint and on profile of exhaust gland) Dowel position and half joint bolting, no modification required.	
10	Stage 5 Extraction Spool Piece	Piston rings carried in floating C shaped carrier, held axial by ring nut. Component assembled as part of inner casing module. Provide new spool end with stellite OD, cut existing spool piece and weld on new end. Spool length cut to suit at site. Inspringing piston rings ID = 10.625".	
11	Stage 2 Leakoff (IP Rotor cooling steam)	Piston rings carried in floating C shaped carriers, held axial by ring nut. Component assembled as part of inner casing module. Provide new spool piece, to be machined at site to suit existing outer casing flange. Inspringing piston ring ID = 94mm	
12	Outer casing push pull keys	The IP rotor front coupling face provides the axial datum for the new module. Push pull keys may need adjusting to move casing casing to best position	

IP7008850

13	HP Inner casing module build	Similar to Genesee HP replant. 1. On initial build, module to be lowered onto dummy packers, with transportation brackets fitted top and bottom. Packers thickness to be determined. 2. With contract packers fitted, module to be lowered with bottom half transportation packers removed. Bottom half exhaust gland to be located about rotor. (see photographs). 3. Top half transportation brackets to be removed with module in position.	
14	HP/IP Coupling	New sleeves to be ordered by customer Nominal size =	
15	HP stub shaft	Locating diameter of stub shaft unknown. Fit spacer between rotor end and stub shaft, to be adjusted at site.	
16	Axial clearances	Axial clearances on existing glands:- No change at front. At rear, C to increase and E to be reduced.	

Part F - Detailed Specifications

Division F2 - Technical Requirements

1.0 General:

This specification provides the technical information required for providing both products and services associated with supply and replacement of the high pressure turbine sections, overhaul of the intermediate pressure turbine, internal alignment of these two sections and technical direction services for effectively completing all turbine work scheduled for both the March, 2003 Unit 1 Outage and the March, 2002 Unit 2 Outage at the Intermountain Generating Station (IGS).

2.0 Unit Description:

Intermountain Generating Station consists of 2 sister units operating S-2, triple tandem-compound, single reheat, 20- stage, impulse type turbines with a double-flow nozzle. The high pressure turbine is a partial arc design with 7 stages and one, 4th stage extraction. The turbine is controlled via a Mark II series electrohydraulic system.

The turbines have been increased in nominal output rating from an original installation output of 840 MWg to a current rating of 875MWg.

3.0 IPSC Planned Turbine Scope of Work:

The planned scope of work for the turbine generator during the Unit 2 outage beginning March 2, 2002 is:

- Replacement of the HP turbine section
- Major inspection and overhaul of the Intermediate Pressure Turbine section
- Testing and possible disassembly of the generator for repair of stator winding leaks.
- Main stop, control, combined reheat and ventilator valves
- Overhaul of servos, switches and PMG at front standard

The planned scope of work for the turbine generator during the Unit 1 outage starting March 1, 2003 is:

- Replacement of the HP turbine section
- Major inspection and overhaul of the Intermediate Pressure Turbine section
- Testing and possible disassembly of the generator for repair of stator winding leaks.
- Main stop, control, combined reheat and ventilator valves

- Overhaul of servos, switches and PMG at front standard

The above scopes of work are to be provided for each of two units at the Intermountain Generating Station during their respective outages. Bidders are encouraged to respond to the above specified outage start dates if possible. If adherence to the above dates places significant risk in either quality or delivery of the HP turbine section, the bidder may propose an alternate schedule for outage start date. Proposals with modified outage start dates more than 1 month later than those specified above, will likely be untenable.

4.0 Scope of Supply:

The scope of this specification includes the following:

1. Design, manufacture, shop testing and delivery of a new, high efficiency HP turbine section.
2. Field engineering services for on-site direction during installation of the new HP turbine section, overhaul of the IP section, overhaul of control, stop and combined reheat valves, overhaul of front standard servos and instrumentation and testing and operation of the completed turbine as listed in Section 6.0.
3. Field direction of electrohydraulic control system modifications for optimized valve operation including parts as required.
4. Internal alignment services for both the HP and the IP turbines.

5.0 Design Conditions & Criteria

The justification for this project rests on both performance and output. Therefore, all reasonable effort shall be made to identify and incorporate the most current and proven performance related technologies.

IPSC understands that by design, the new, high efficiency HP turbine sections are unable to provide both partial arc and full arc operational modes. Accordingly, IPSC chooses to specify a full arc operational design to take advantage of upper end operating efficiencies.

As a part of the modification to exclusive, full-arc control, the supplier shall provide required hardware and technical support for modifying existing valve operation. The supplier shall ensure that valve control, unit stability and generation flexibility are not restricted, encumbered or complicated beyond current capabilities.

The HP section shall be designed for the following throttle conditions and flow passing capability at valves wide open:

- 2400 psi
- 1000 F
- ????????? lbs/hr

The supplier shall be solely responsible for ensuring that all piping penetrations, instrument taps/wells, interfacing keys and supports, journals, couplings, snout sections, seals, etc. are of proper location and dimension.

Maximum allowable vibration in any plane in the fully assembled and operating turbine is 2 mils p/p, overall reading.

The HP turbine sections provided for installation on Unit 1 and Unit 2 shall be operationally interchangeable in every regard.

6.0 Field Service Engineering

Field Service Engineers shall arrive on-site no later than two days prior to the respective outage scheduled start dates. Field Service Engineers shall be available in accordance with the planned outage shift schedule, from two days prior to the outage scheduled start date, until released by IPSC following successful startup and operation of the turbine.

At least two qualified Field Service Engineers shall be provided, one for the day shift and one for the night shift. The engineers shall perform the following functions:

-Technical direction to IPSC for disassembly, cleaning, inspection, repair, part replacement, reassembly, rotor alignment, balancing, etc. of the steam turbine-generator.

-Assist IPSC with overhaul planning, schedule preparation and schedule updating.

-Prepare, and submit to IPSC, a technical report which details the inspections, repairs, and future recommendations related to the work done on the turbine-generator.

The Field Service Engineers shall have had formal training for field engineering on large, impulse design, steam turbine-generators. The Field Service Engineers shall have at least 10 years of field engineering experience in installation, repair and operation of these type machines.

7.0 Internal Alignment Services

The supplier shall provide labor, supervision, expertise, tools and equipment for full internal alignment of the HP and IP sections of the turbine. Where laser alignment technology is employed the supplier shall test all equipment at his shop prior to mobilizing to the site to prevent downtime due to faulty equipment.

The supplier shall provide adequate numbers of trained personnel in order to judiciously pursue completion of the internal alignment without interruption, during the scheduled alignment window.

Alignment personnel must be able to effectively coordinate all alignment information with the Field Service Engineers at the site, regardless of corporate affiliation. Personnel conducting turbine internal alignment work shall be trained and qualified in the procedures used and in operation of the equipment required for the work. The personnel shall have performed the same work on at least ten previous occasions, and at least five of those on large, impulse design steam turbines.

8.0 IPSC Provided Facilities

IPSC shall provide a single desk in an enclosed office trailer on the turbine deck for the field engineers to use. The trailer will also be occupied by IPSC personnel.

IPSC shall provide a single telephone line in the office trailer for use by the Field Service Engineers.

IPSC shall provide access to a fax and copy machine for use by the Field Service Engineers.

9.0 Reference Drawings

-Original acceptance heat balance (Figure 1)
-Current heat balance (Figure 2)

10.0 Operating Experience

Intermountain Generating Station has operated for the past 5-6 years with net capacity and availability factors in excess of 90%. Net output in excess of 95%.

Weekly valve and yearly tightness and overspeed testing has been successfully completed since original installation.

Turbine startups have been relatively smooth on both units. Only rarely is a balance shot required during startup.

On-line vibration is rarely above 3 mils p/p on any bearing. With continuous vibration archiving and trending capability, actions levels are based both on rates of change and on absolute vibration levels.

A load profile (Figure 3), typical of recent years is enclosed for your information.

11.0 Maintenance History and Provisions

The Intermountain turbines were overhauled completely by the OEM, on one occasion approximately 2 years after commercial operation. Since that time all maintenance on the turbines has been performed by IPSC personnel under the direction of a Field Service Engineer.

Turbine oil is monitored by on-site, predictive maintenance personnel who are fully trained in ferrographic, particulate and inductively coupling plasma analysis. The turbine oil was recently replaced on both units as the oil additive packages were showing signs of degradation affecting the oil/moisture separation properties. However, moisture has remained continually within allowable limits.
IPSC is aware of no dimensions affecting the installation of a new HP that have been modified since installation. The only significant modifications to the turbine since startup are follows:

- Hydraulic Coupling Bolts, (Ovako, Inc.)
- Retractable Packing, (Turbocare, Inc.)

The IPSC turbine bay crane is rated at 95 tons.

12.0 Manufacturing Schedule

Within six weeks of award, the supplier shall submit a detailed schedule showing all facets of completion of the HP turbine section and associated components. The schedule shall include:

- Order placement for material stock for each major component
- Expected delivery to manufacturing facilities of stock for each major component.
- Start of material acceptance testing for each major component
- Start of manufacture of each major component
- Start of shop testing for each major component
- Start of component sub-assembly, (i.e. rotor assembly, diaphragm assembly, etc.)
- Start of sub-assembly testing, (i.e. rotor testing, diaphragm NDE and final dimensions)
- Start of assembly (alignment, etc.)
- Final assembly dimensional verification

Updated manufacturing progress reports shall be prepared and submitted to IPSC on a monthly basis up to the date of final inspection and shipment. In addition to updated manufacturing and testing schedules, the supplier shall provide notification of testing identified by IGS as 'witnessed tests' in Section 17.0, 'Quality Assurance', at three separate intervals prior to the day of the test in order to allow for IGS travel arrangements:

- 30 days prior to the test
- 14 days prior to the test
- 7 days prior to the test

The supplier shall provide construction drawings for approval by IPSC prior to start of fabrication. Required approval date shall be clearly identified at the time of construction drawing submittal to IPSC. Approval of construction drawings shall not relieve the supplier of sole responsibility for proper design and manufacturing accuracy and quality,

13.0 Delivery Schedule and Incentives

The Unit 2 HP turbine section and associated components shall be delivered at the IGS facility no later than February 18, 2002.

The Unit 1 HP turbine section and associated components shall be delivered at the IGS facility no later than February 17, 2003.

For delivery of the HP section to the site two (2) weeks ahead of the outage start date the supplier will be allowed to avoid two days of penalty beyond his guaranteed installation schedule prior to any penalty being assessed. This means that with delivery two weeks ahead of the scheduled outage date, the maximum outage extension penalty will be reduced to $800,000 and will not begin accumulating until two days past the guaranteed installation schedule identified within the bid.

For delivery to the site after 12:00 midnight on the respective IGS delivery dates noted no early payment shall be made.

For delivery after March 1, 2002 for Unit 2 or after February 28, 2003 for Unit 1, a penalty of $200,000 will be assessed to the supplier to assist in paying for rebuild of the existing HP turbine section.

14.0 Installation Schedule and Incentives

IPSC is encouraging base and alternate bids that key on innovative methods for minimizing installation schedules while maintaining verifiable installation quality. The respective outages have a currently scheduled nominal length of 30 days. This 30 day schedule is defined as 'Breaker Open' to 'On-Line and Available for Full Load'.

All bidders shall prepare a 'guaranteed' installation schedule for the HP turbine replacement. The bid outage schedule for replacement of the HP turbine section shall provide detail from 'Breaker Open' to ' Turbine on Turning Gear'. The current maintenance schedule shows this as approximately 28 days.

The bid schedule shall include task level detail for removal of the existing HP section, field accommodation work within the existing HP shell and full installation of the new HP section including alignment. Major milestones shall include as a minimum:

- New HP components staged and ready for installation
- Turbine off gear and lube oil isolated
- Removal of HP outer shell
- Removal of HP rotor
- Removal of HP L/H casing
- Completion of L/H outer shell prep work and dimensional verification
- L/H casing installed
- Alignment complete
- Rotor installed
- U/H casing installed
- U/H outer shell installed
- HP installed and coupled

The current maintenance schedule is based upon a dedicated, HP turbine section crew consisting of 6 maintenance mechanics working 2 each 10 hour shifts per day, 6 days per week.

For each day that the outage length is extended due to the supplier's products or actions or the direct installation requirements of the new HP turbine section, the supplier shall be assessed a penalty of $100,000. The penalty maximum assessed for outage extension shall be 10 days or $1,000,000.

If the turbine section is delivered late and IPSC elects to proceed with installation of the new HP turbine, no outage extension penalty shall be assessed unless and until the suppliers bid installation schedule is exceeded due to the suppliers products, actions or direct installation requirements.

At least 90 days prior to the respective scheduled outages the supplier shall have a coordination meeting with IPSC Outage Management and prepare a complete installation information package based on the specific approach and schedule selected by IPSC. This final detailed schedule shall be provided to IPSC within 10 working days of the coordination meeting and shall provide completely detailed sequential instructions on installation and alignment of the HP section, including any modifications to existing HP section hardware, special tooling, equipment or services that may be required.

Both the outage schedule and duration are subject to change by IPSC. In the event of any IPSC initiated schedule change, IPSC will immediately notify the supplier and negotiate a mutually agreeable resolution.

The supplier shall identify within their prepared outage schedule, any interface concerns with the simultaneous overhaul on the IP turbine including bearing type/composition and positioning, coupling alignment, etc.

15.0 HP Section Performance Testing:

Initial performance testing shall occur as soon after the outage as reasonably possible. IPSC anticipates the ability to complete the initial performance testing within 1-2 weeks of startup. However, several factors could develop that could delay the test, these factors include an inability to achieve stable or acceptable turbine vibration limits, lack of permission from dispatch authority, unforseen load demands or problems with other plant equipment.

In addition to initial performance testing, IPSC will complete a confirmation test approximately 30 days following initial performance testing. Performance incentives/penalties shall be calculated and awarded based on the average of the initial performance test and the 30 day confirmation test.

The supplier is invited to be present during all testing. IPSC will apply best effort to confer with the supplier regarding all issues that may affect the evaluated performance of the turbine.

IPSC will prepare a specification and engage a qualified contractor for the performance tests. For general information the following criteria will form the basis of the performance testing:

1. The unit shall be operated at steady state, full load for approximately 1 hour prior to start of test.
2. Steady state shall be defined as fluctuations of not greater than:
    - 1.0% of absolute pressure readings
    - 5.0 degrees F, temperature readings
3. Test shall consist of a minimum 60 minute test, with readings taken a minimum of every 2 minutes.
4. Target testing criteria shall be throttle flow of ??????lbs/hr @ 2400 psi throttle and MWg output of ???????.

Testing tolerance for all forms and all sources of testing uncertainty shall be 0.25%. This is based on the following testing accuracies:

- 0.1%, throttle pressure
- 0.1 psi, HP exhaust

- 0.5 degrees F, all temperatures

All readings shall be taken at two parallel points allowing for direct indication of faulty equipment. Both elements shall be monitored and recorded during the equalization period and throughout the performance test for increased accuracy. All testing instrumentation shall be calibrated and traceable to NBS Standards. Instrumentation shall be calibrated both before and after testing is complete.

The cost of one initial performance test following the outage and one confirmation test approximately 30 days subsequent, will be borne by IPSC. All testing shall be considered valid and contractually binding if the HP section efficiency is tested to be no more than 2.0 percentage points below design efficiency.

If the measured section efficiency, during either the initial performance test or the 30 day confirmation test is more than 2.0 percentage points below design, an additional test shall be run and paid for by IPSC, as soon after the first test as operationally reasonable.

If the first test is within the 2.0 % window or if the second test is outside(below) the 2.0% window, the first test results shall be valid and contractually binding.

HP section efficiency shall be defined as measured across both the valves and the HP section; from throttle conditions to the HP section exhaust.

16.0 Performance Guarantees and Incentives:

****

<u>TO PURCHASING: THIS COULD GO IN A COMMERCIAL SECTION</u>

Bidders shall be awarded a bid evaluation credit (not payable dollars) of $10,000 for each 0.1% in HP section efficiency, above 91%, that is guaranteed in the respective bid.

Bidders shall be awarded an evaluation credit (not payable dollars) of $50,000 for each megawatt of generation capacity above ?????????? MW at VWO, 2400psi throttle, guaranteed in the bid.

****

Supplier shall be penalized ????????? if throttle flow at VWO, 2400psi exceeds 6,975,000 lbs/hr. This penalty covers near term reduced pressure operation and required system modifications.

The supplier shall be awarded a cash incentive of $10,000 for each 0.1% in performance that is confirmed by the performance test results above 92%, up to a maximum performance cash incentive of $100,000. No testing tolerance shall be applied above 92% prior to calculating the performance incentive.

The supplier shall be penalized $10,000 for each 0.1% below guaranteed HP section efficiency that is confirmed by the performance test results, up to a maximum penalty of 100,000. This penalty shall not take effect until after the 0.25% testing tolerance has been applied.

The supplier shall be awarded a cash incentive of $50,000 for each Megawatt of generation in excess of the bid guarantee that is proven during the initial and 30 day confirmation performance testing, up to a maximum of 5 Megawatts or $250,000.

The supplier shall be penalized $50,000 for each Megawatt of generation below the bid guarantee output that is confirmed during the initial and 30 day confirmation performance testing, up to a maximum penalty of $250,000.

17.0 Quality Assurance:

Vendor shall implement a quality assurance program addressing all phases of design, manufacture, installation and startup of the HP turbine section. The purpose of the HP section Q/A program is to assure that:

1. Design documents, drawings, specifications, quality assurance procedures, inspections procedures and purchase documents are maintained current, accurate and under control.

2. The purchased materials, equipment and services conform to the requirements of these documents.

3. Receipt inspections, in-process inspections, examination and testing are complete and appropriate.

4. Subcontracted work is adequately inspected and monitored.

5. Special processes such as welding, heat treating, hot forming and NDE are of adequate quality

6. Welders and NDE personnel are adequately qualified.

7. Nonconforming equipment and materials is properly documented, controlled and dispositioned.

IGS shall have full access, at all times, to the quality assurance procedures, instructions and nonconforming reports applicable to the equipment and materials furnished under this contract.

The quality assurance manual shall include the manufacturing locations of each major component, all tests to be performed on each component and assembly and shall list the individuals with respective phone numbers that will be in charge of quality verification at each site.

The supplier shall, as a minimum, provide for the following levels of documentation, review and acceptance of quality assurance procedures and reporting on all major components including the following:

1. Rotor
2. Buckets
3. Diaphragms
4. Inner Casing
5. Inner Casing Bolts
6. 1st Stage Nozzle

(Test Definitions Note:
Witness: The test may be attended by an IPSC representative
Review: IPSC shall review the test results prior to start of mfg.
Copy: IPSC shall receive signed copy of the test results within 1 week.)

	Witness	Review	Copy
Chemical/Mechanical Properties			1,2,3,4,5,6
Mill Certifications			1,2,3,4,5,6
Heat Stability Testing			1
Non-destructive Testing (Incl. welds and castings)		1,2,3,4,5,6	
Dimensional Checks	1,2,3,4,5,6		
Balance/Overspeed Testing		1	
Final Shipping Inspection	1,2,3,4,5,6		

Additional examination or testing may be required by IPSC of any welds, castings or forgings with indications exceeding code allowables or those having been or requiring repair.

Where designs incorporate sectionalized rotors, the root welds shall be examined using MT methods. Final passes shall also examined using MT and shall examined using UT from three angles of maximum reasonable variation.

18.0 Bid Submittals:

In addition to any other requirements of these specifications, the supplier shall provide the following information with the bid submittals:

1. A list of all components provided, with mfg. part numbers and including component life expectancy.
2. Balance criteria to be imposed by supplier .
3. Estimated Shipping Weight and Installation Weight of assembled HP
4. Detailed explanation of methods and equipment to be used in performing turbine internal alignment.
5. List of any additional items which the contractor will need IPSC to provide, other than those listed in Section 8.0.
6. Resume and experience list for each field service engineer, technician, or other personnel to be involved in the IGS based portions of the work.
7. Detailed plan for any on-site inspection work that must occur in advance of the installation, including the upcoming Unit 1 outage beginning March 5, 2001.
8. A best approximation schedule for completing the following major milestones: (to be shown in multiples of 10 hour shifts using up to 6 trained turbine mechanics)

-Old casing out
-New casing on final shims
-Rotor Aligned in bearings
-HP reassembled

9. A list of any special tools required for installation or maintenance of the new HP section. Including balance weight placement or casing guide pins.
10. A list of recommended spare parts associated with the HP section. The list shall include estimated life of each component and location/quantity of any supplier warehoused stock of each item.
11. Applicable section of each code and/or standard used in development and design of the HP turbine section including:
    ASTM - Materials Standards
    ASME - Performance and Construction Standards
    AISI - Material Standards
    ISO - Balance Standards (or applicable international standard)

19.0 Contract Document Submittals:

During the course of fabrication of the HP section, the supplier shall expeditiously submit the following information in accordance with the monthly updated, manufacturing schedules and reports outlined in Section 12.0:

1. Construction/fabrication approval drawings
2. A revised thermal kit based on the throttle conditions
3. Ongoing Q/A reports as specified in Section 17.0
4. Mill Certificates
5. Manufacturing progress reports
6. Rotor Balance Report including static unbalance at critical speeds and rated speed
7. Rotor Runout Report
8. Calculated Rotor Torsional Characteristics
9. Assembly and Interface Dwgs
10. Component and assembly rigging plan including accurate weight of each lift.
11. Piping connection and instrumentation port location drawings
12. Within 30 days after award the contractor shall submit a schedule of submittals including all drawings, by title and their estimated submittal and approval return dates.
13. Itemized list of each component type showing individual design weight.

20.0 Existing HP Section Availability

The existing, Unit 1, HP turbine at IGS is currently scheduled to be available for inspection, measurement and condition assessment during the upcoming outage currently scheduled to begin March 5, 2001. The following items are scheduled to be completed at that time:

1. The upper half HP section outer shell will be removed.
2. The 4th stage extraction line will be severed and drifted to allow access from the outside.

If the bidder desires to take advantage of this inspection opportunity, the bidder shall prepare and provide a detailed inspection plan along with the bid submittals as outlined in Section 18. The plan shall include the significant, foreseeable economic or schedule impacts that may occur as the result of the information to be gathered during the outage.

The successful bidder shall have up to four (4) days of access for inspection of the HP turbine on Unit 1. **The HP turbine inner casing will not be open.**

21.0 Shipping

All components and assemblies shall be packaged, coated, supported and secured to prevent corrosion, damage or deformation during shipping. Any damage sustained prior to delivery at the IGS facility shall be judiciously corrected by and to the account of the supplier.

Bearing journals areas shall be securely covered and protected by treated cotton cloth or acceptable equal to prevent inadvertent contact or corrosive elements.

22.0 Maintenance Manuals

The supplier shall provide 10 sets of maintenance manuals at time of delivery, including the following information:

- Detailed overhaul recommendations
- General Arrangement Dwgs.
- Rotor Clearance Drawings
- Diaphragm Alignment Dwgs
- Longitudinal X-section Elevation
- Shaft Torque Characteristic Plot

23.0 Warranty

Due to IPSC outage schedules, the supplier's warranty must extend at least two years beyond installation in order to verify the cause of and correct any significant efficiency reductions. Due to operational priorities, access to turbine components for warranty adjustments shall be at the discretion of IPSC.

IPSC shall retain the right to operate the components and equipment provided under these specifications regardless of any outstanding warranty issues. The supplier shall be released from any additional claims for damage incurred as direct result of such continued operation. Warranty obligations for defects not attributable to such continued operation shall remain the responsibility of the supplier.

Supplier shall provide schedule identifying any maintenance procedures or testing/inspection required to maintain the bid warranty provisions.

Bid Totals

		Unit 1(2003)	Unit 2(2002)
1.Price for Fully Assembled HP Turbine Section		________________	________________
2.Price for Aligned /Partially Dis-assembled Section		________________	________________
3.Price for Freight	(Fully Assembled)	________________	________________
	(Partially Assembled)	________________	________________
4.Contract Cancellation Cost:	>16 mo. before ship	________________	________________
	12-16 mo. before ship	________________	________________
	10-12 mo. before ship	________________	________________
	6-10 mo. before ship	________________	________________
	< 6 mo. before ship	________________	________________
5. Field Service Engineering		________________	
		________________	

(To include all labor, expertise, travel, expenses and services.)

6. Field Service Engineering Rates for Unanticipated Work Hours:	Regular Hours	________________	________________
	10-16 Hrs/day	________________	________________
	Holidays	________________	________________

Travel time ______________ ______________
Expenses/day ______________ ______________

7. Turbine Internal Alignment Services ______________ ______________
   (To include all labor, travel, expertise, expenses, equipment and services.)

8. Guaranteed HP Section Efficiency ______________ ______________
   (Measured across both valves and HP section.)

9. Guaranteed Gross Unit Output ______________ ______________

10. Price for Optional Retractable Packing ______________ ______________
    (Packing design must be approved by IPSC representative.)

11. Guaranteed Delivery Dates ______________ ______________

COMMERCIAL NOTES TO PURCHASING:

The bidder shall a provide a required payment schedule,

All costs associated with any reverse engineering shall be included with the original bid.

From: <adrian.bramley@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 5/1/01 9:15AM
Subject: Intermountain Generating Station Heat Balance Diagrams

fyi
---------------------- Forwarded by Adrian BRAMLEY/LTR/STG/PGD/GECALSTHOM on 01/05/2001 16:08 ---------------------------

|--->
| Inter Mountain 1 and 2 Retrofit |
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| Document |
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| Author | |
|--------+--->
>---|
| Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM |
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| Posted | |
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| 24/04/2001 14:20 |
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| To | |
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| Adrian BRAMLEY/LTR/STG/PGD/GECALSTHOM@GA |
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| Robert BROWN/LTR/STG/PGD/GECALSTHOM@GA, Alan |
|HESKETH/LTR/STG/PGD/GECALSTHOM@GA |
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| Title | |
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| Intermountain Generating Station Heat Balance Diagrams |
>--|

Adrian,
Please find attached diagram TS29247A, this being a preliminary heat balance diagram for Intermountain Unit 2 at Valves Wide Open, 6.9Mlb/h flow, 2400psig/1000°F/1000°F.
We have prepared this diagram in response to a request from David Spence that we received on 18/4/01. Please issue to IPSC.
Phill.

(See attached file: ts29247a.pdf)
---------------------- Forwarded by Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM on 24/04/2001 14:16 ---------------------------

"Dave Spence" <DAVE-S@ipsc.com> on 17/04/2001 21:31:32

To: Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM@GA
cc:
Subject: Intermountain Generating Station Heat Balance Diagrams

IP7008867

From: <phill.kearney@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 2/21/01 9:18AM
Subject: Intermountain HP Upgrade

James,

Please find attached a WinZip file "IntermountainDocs.zip" containing the following Word documents for your information.

Unit 1 Boiler Interface Conditions after HP upgrade
Unit 2 Boiler Interface Conditions after HP upgrade
Unit 1 & 2 Boiler Duties
Unit 1 & 2 Feedwater Heater Design and Operating Data
Unit 1 & 2 Heater 8 Duty
Performance Testing Options

You will recognise these documents as being similar to the handwritten notes we left with you at the end of our visit in January. We have updated the information supplied for unit 1 in those handwritten notes in the light of further analysis of the unit 1 test results. Also, now that we have analysed the unit 2 test data (we only looked at unit 1 while we were visiting you) we have been able to include boiler and heater information for that unit as well as unit 1.

Also included in the WinZip file are the following two documents.

Unit 1 HP Power and Efficiency after HP upgrade
Unit 2 HP Power and Efficiency after HP upgrade

These summarize the HP efficiency and shaft output for units 1 and 2 after the HP upgrade.

We hope you will find these documents useful.

Best Regards,
Phill Kearney

(See attached file: IntermountainDocs.zip)

CC: <dave-s@ipsc.com>, <robert.brown@power.alstom.com>, <alan.hesketh@power.alstom.com>, <gerry.davis@power.alstom.com>, <bill.rudman@power.alstom.com>, <adrian.bramley@power.alstom.com>

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From: <robert.brown@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 8/8/02 10:46AM
Subject: Intermountain 1 & 2 - HP Swallowing Capacity

James,

Attached is a summary of the calculations we've carried out, and a note of the telephone discussions we've had regarding Unit 2 HP turbine swallowing capacity and the requirement for Unit 1.
You'll note that the figures for Unit 2 have slightly changed from those given over the phone yesterday - this is a consequence of double-checking to make sure we've done the calculations correctly !

If you have any questions regarding the note, or Unit 1 capacity, please call.
Regards,
Bob

(See attached file: INTERMOUNTAIN UNITS 1 & 2.doc)

CC: <adrian.bramley@power.alstom.com>, <kevin.spires@power.alstom.com>, <phill.kearney@power.alstom.com>, <joyce.moore@power.alstom.com>

From: <alan.holmes@power.alstom.com>
To: "James Nelson" <jim-n@ipsc.com>
Date: 6/22/01 7:02AM
Subject: Intermountain - Extraction pipe

We intend to supply a complete length extraction pipe and do away with the high/low rings. We might supply a sleeve in place of the high/low rings or we might build up that area of the new extraction pipe with weld to form in effect an integral sleeve. We have not decided the detail yet but either way the high/low rings will go.

Regards
Alan

CC: <leigh.thornton@power.alstom.com>, <adrian.bramley@power.alstom.com>

From: <phill.kearney@power.alstom.com>
To: <jim-n@ipsc.com>, <Dave-s@ipsc.com>
Date: 6/7/01 8:54AM
Subject: Intermountain Generating Station - valve pressure drop.

James/Dave
Thanks for the valve pressure drop information. As the pressure drop is less than the 3% previously specified we need to reduce the swallowing capacity of our design as it stands at the moment to avoid the retrofit machine being too big.

From the figures you supplied, the average valve pressure drop is 2.06%, but we do not know what the flow was when you took this measurement. Also, as you know, from our analysis of your previous test data we have reservations about the accuracy of the flow measurement nozzle on unit 1.

However, from our analysis of your 1998 BMCR test data from unit 1 we have deduced that the Unit 1 flow should be 6,442,868 lb/h at 2400psig/1000F.

Therefore we believe your valve dp of 2.06% corresponds to a flow of 6,442,868 lb/h. After the retrofit, with 6,900,000 lb/h flow the pressure drop will increase proportional to the square of the flow.

ie after retrofit valve dp = 2.06% x (6,900,000/6,442,868)^2 = 2.36%

Therefore, we intend to design the retrofit HP to pass 6,900,000 lb/h at VWO 2400psig/1000F with a 2.36% pressure drop from inlet to valves to inlet to HP cylinder.

Please urgently indicate that you are in agreement (or otherwise) with the above assumption so that we may progress with the design. Thanks.

Regards,
Phill Kearney.

"James Nelson" <jim-n@ipsc.com> on 05/06/2001 21:42:28

To: lee.thornton@power.alstom.com, phil.hennesy@power.alstom.com, Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM@GA, Richard PLANT/LTR/STG/PGD/GECALSTHOM@GA
cc: "Aaron Nissen" <AARON-N.TS_POST.IPSCOF@ipsc.com>, "Dave Spence" <DAVE-S.TS_POST.IPSCOF@ipsc.com>, "Phong Do" <PHONG-D.TS_POST.IPSCOF@ipsc.com>
Subject: Additional Info from Intermountain Generating Station

Richard,
Adrian asked that I send the valve pressure drop data directly to you as it became available. Would you please also check the addresses for Phil Hennesy (sp?) and others to make sure they received this data as well.

We completed pressure drop measurements across the U1 HP turbine stop and control valves yesterday afternoon. Measurements were taken at throttle valves wide open and design (2400 psig) throttle conditions. We measured pressure with our Heise PT-E1 pressure calibrator with a 0-3000 psi HQS-2 pressure sensor which has been calibrated to 0.05% full scale accuracy. Reported pressures have been compensated for sensor line water leg and throttle pressure variations between measurements.
Upstream pressures were measured at the main steam header lead test taps ahead of the stop and control valves. All pressures are psig.

dp from hdr lead #3 to turbine lead from CV 1D2 #4 (lead to bottom of turbine)
2393.2 - 2342.1 = 51.1 (-2.14%)

dp from hdr lead #4 to turbine lead from CV 1C2 #3 (lead to top of turbine north side)
2389.5 - 2342.3 = 47.2 (-1.98%)

The numbers shown above are the drops we would consider to be those applicable to the turbine design. These are also the taps we anticipate using within the HP section performance testing. In addition to these, for reference only, we also measured and calculated pressure drops from the main steam pressure control point (1COAXI012A) to the CV lead pressure taps. Note that the main steam pressure control tap is from the main steam line before it splits into the header leads.

dp from main steam pressure control point to turbine lead line from CV 1D2 #4
2405.3 -2345.6 = 59.7 (-2.48%)

dp from main steam pressure control point to turbine lead line from CV 1C2 #3
2394.6 - 2340.9 = 53.7 (-2.24%)

Also, for Phil Kearney and Bob Brown I just wanted to reiterate the following regarding our request for heat balance diagrams. We would request the following:
1. VWO,2400, 6.9Mlb/h (976) already received the preliminary for Unit 2
2. 100% load - 950 MW
3. 75% load - 712.5 MW
4. 50% load - 475 MW
5. 32% load - 300 MW
All of these HBD's at design throttle (2412.2 psia, 1000 deg) and reheat (1000 deg) conditions.

Also, the engineer that I have assigned to work directly with the installation coordination aspects for Unit 1 and 2 is Mr. Phong Do. Lee would you please confirm if you or Adrian recieved a sizeable stack of information from Phong recently. I failed to ask Adrian yesterday before he left on vacation.

Upon my visit to Rugby, Adrian was working to assemble a significant portion of the pages of info that we discussed there. I received a few outline drawings of a G3 machine today which is of definite interest but am still looking forward to receiving the main body of info we reviewed during my visit. If Adrian didn't get a chance to send these pages before he left we my have to await his return.

Richard, Rob Cunningham and I discussed a couple ideas regarding how we might secure the existing rotot to the inner casing for removal. We are still discussing this idea here. We would appreciate any ideas from Alstom that might contribute to this discussion. I am aware that the utility in Missouri where Alstom recently replaced an HP section, just picked up the rotor and allowed the diaphragm packing to bear the weight of the inner casing. How legitimate does Alstom consider this approach? How about welding a bracket to the casing?

You may contact me at jim-n@ipsc.com .
Regards
James Nelson

CC: <robert.brown@power.alstom.com>, <adrian.bramley@power.alstom.com>, <phil.hennessy@power.alstom.com>

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To: "James Nelson" <jim-n@ipsc.com>
Date: 6/22/01 7:02AM
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ALSTOM

Intermountain Units 1 and 2
Results of Heat Balance with HP Heaters Isolated

Comparison of pressures with HP heaters isolated

Heater No.	Design max pressure (psia)	5% O/P OEM	TS29247 VWO	One Heater String Isolated		Top 6 Heaters Isolated		One Top Heater isolated		Both top heaters isolated		One HP 7 heater isolated		Both HP 7 heaters isolated		One HP 6 heater isolated		Both HP 6 heaters isolated	
				VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling
1	62.4	4.4	5.1	5.6	5.2	6.3	5.2	5.3	5.2	5.5	5.2	5.2	5.2	5.3	5.2	5.2	5.2	5.2	5.2
2	62.4	10.5	12.2	13.4	12.2	15.0	12.2	12.6	12.2	13.0	12.2	12.4	12.2	12.6	12.2	12.2	12.2	12.3	12.2
3	87.4	37.2	42.2	46.3	42.3	52.1	42.3	43.6	42.2	45.0	42.2	42.9	42.2	43.6	42.2	42.4	42.3	42.5	42.3
4	112.4	82.5	70.7	77.[illegible]	70.7	87.[illegible]	70.7	73.[illegible]	70.6	75.[illegible]	70.7	71.[illegible]	70.7	72.[illegible]	70.7	70.[illegible]	70.7	71.[illegible]	70.7
5 (deaerator)	161	124.0	135.1	14[illegible].3	135.0		135.0	13[illegible].5	135.0	14[illegible].9	135.0	13[illegible].2	135.0	13[illegible].4	135.0	13[illegible].5	135.1	13[illegible].9	135.1
IP Exhaust Pressure		127.8	137.2		137.2		137.2		137.2		137.2		137.2		137.2		137.2		137.2
6	312.4	231.1	257.8	282.5	256.8	O/S	O/S	265.9	257.2	274.3	256.9	261.7	257.5	265.8	257.3	258.4	257.7	O/S	O/S
7	812.4	584.7	616.2	663.2	602.2	O/S	O/S	635.7	614.4	656.2	614.0	625.3	615.0	O/S	O/S	604.7	603.0	580.0	576.7
8	1387.4	1081.5	1084.4	1134.6	1028.3	O/S	O/S	1124.2	1085.2	O/S	O/S	1065.1	1047.3	1012.4	980.6	1076.6	1073.3	1067.9	1061.2

Isolated heaters (O/S) assumed vented

Comparison of flow/ power output/ heat added with HP heaters isolated

		TS29247 VWO	One Heater String Isolated		Top 6 Heaters Isolated		One Top Heater isolated		Both top heaters isolated		One HP 7 heater isolated		Both HP 7 heaters isolated		One HP 6 heater isolated		Both HP 6 heaters isolated	
			VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling
Throttle Flow (Mlbs/h)		6.9059	6.805	6.138	6.666	5.338	6.825	6.576	6.747	6.285	6.937	6.810	6.973	6.725	6.914	6.890	6.927	6.879
Power Output (MW)		973	1019	923	1084	870	991	958	1009	942	979	962	985	952	972	969	971	965
Heat Rate (Btu per kW h)		7683	7[illegible]21	7880	7[illegible]94	8106	7[illegible]20	7743	7[illegible]54	7797	7[illegible]16	7728	7[illegible]46	7769	7[illegible]96	7698	7[illegible]07	7712
Percentage increase of heat added		0.0 (datum)	6.5	-2.8	15.9	-5.6	2.3	-1.0	4.6	-1.7	1.0	-0.6	2.1	-1.1	0.1	-0.2	0.1	-0.5

Flow through each exhaust of LP turbine

	Maximum Allowable	TS29247 VWO	One Heater String Isolated		Top 6 Heaters Isolated		One Top Heater isolated		Both top heaters isolated		One HP 7 heater isolated		Both HP 7 heaters isolated		One HP 6 heater isolated		Both HP 6 heaters isolated	
			VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling	VWO	Throttling
Mass Flow (lb/h)		672380	733721	671174	820963	669988	693499	672153	714632	672287	682632	672296	692864	672151	673118	671217	673699	669848
Flow (lb/ft^2 per hour)	15000	12093	13196	12071	14766	12050	12473	12089	12853	12091	12278	12092	12462	12089	12106	12072	12117	12048

23rd July 2002 JM

IP7008876

From: <phill.kearney@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 2/21/01 9:18AM
Subject: Intermountain HP Upgrade

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From: <adrian.bramley@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 5/1/01 9:15AM
Subject: Intermountain Generating Station Heat Balance Diagrams

fyi
---------------------- Forwarded by Adrian BRAMLEY/LTR/STG/PGD/GECALSTHOM on 01/05/2001 16:08 ---------------------------

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|     Inter Mountain 1 and 2 Retrofit         |
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| Author |   |
|--------+--->
  >------------------------------------------------------------------|
  | Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM                                  |
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  >------------------------------------------------------------------|
  | Adrian BRAMLEY/LTR/STG/PGD/GECALSTHOM@GA                               |
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 | Robert BROWN/LTR/STG/PGD/GECALSTHOM@GA, Alan                |
 |HESKETH/LTR/STG/PGD/GECALSTHOM@GA                        |
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 | Intermountain Generating Station Heat Balance Diagrams          |
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Adrian,
Please find attached diagram TS29247A, this being a preliminary heat balance diagram for Intermountain Unit 2 at Valves Wide Open, 6.9Mlb/h flow, 2400psig/1000°F/1000°F.
We have prepared this diagram in response to a request from David Spence that we received on 18/4/01. Please issue to IPSC.
Phill.

(See attached file: ts29247a.pdf)
--------------------- Forwarded by Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM on 24/04/2001 14:16 ---------------------------

"Dave Spence" <DAVE-S@ipsc.com> on 17/04/2001 21:31:32

To: Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM@GA
cc:
Subject: Intermountain Generating Station Heat Balance Diagrams

IP7008880

ALSTOM

MEMORANDUM

Power
Steam Turbines

To: Adrian Bramley
Project Manager, Rugby

cc: Phil Kearney/ File

From: Joyce Moore
STRGT, Rugby

Date: 24th July 2002

Subject: Intermountain- HP heaters out of service

In response to James Nelson's e-mail (dated 12th July 2002), regarding the ability of the Intermountain turbines to tolerate short term operation with HP heaters isolated, a variety of scenarios were assessed. These scenarios were as follows:

1) One HP heater string isolated
2) All 6 HP heaters isolated
3) One top HP heater (e.g. heater 8b) isolated
4) Both top HP heaters isolated
5) One HP 7 heater isolated
6) Both HP 7 heaters isolated
7) One HP 6 heater isolated
8) Both HP 6 heaters isolated

In addition to determining the LP turbine exhaust flow under these conditions (as was requested), the heater pressures on the steam side of all heaters and the IP exhaust pressure were calculated. The heater pressures were then checked against the design pressures.

The IP exhaust pressure gives an indication of the loading on the latter stages of the IP turbine as well as on the LP turbine stages. This pressure was compared to that given by the predicted performance of the cycle with VWO (see drawing no. TS29247). From Test 8 carried out by PGT in April 2002, it can be seen that the turbines have been run under conditions very similar to those shown on TS29247. This shows the ability of the turbines to tolerate these conditions, although the IP exhaust pressure achieved (137.2 psia) is higher than that previously indicated on the OEM 5% O/P heat balance diagram. (Note: Units 1 & 2 turbines have previously operated at very similar pressure levels during BMCR tests in 1998)

The results showed that under all conditions, the LP exhaust loading was below the design limit of 15,000 lb/ft^2 per exhaust. Heater pressures also fell within design with

Power
Steam Turbines

the exception of the deaerator exceeding its design limit when all 6 HP heaters were isolated at throttle valves wide open (VWO). In all scenarios at VWO however, the IP exhaust pressure exceeded 137.2 psia. Further calculations were carried out in order to find the power output to which the turbines must be limited in order to reduce the IP exhaust pressure a value of 137.2 psia (the maximum normal operating pressure with all heaters in service- subject to review by IPSC/GE).

As a result of the analysis, it is advised that the generator output should be limited to the following when any of the HP heaters are tripped:

1) One HP heater string isolated	923MW
2) All 6 HP heaters isolated	870MW
3) One top HP heater isolated	956MW
4) Both top HP heaters isolated	942MW
5) One HP 7 heater isolated	962MW
6) Both HP 7 heaters isolated	952MW
7) One HP 6 heater isolated	969MW
8) Both HP 6 heaters isolated	965MW

In order to operate at higher loads, it is recommended that IPSC contact GE in order to obtain the maximum allowable conditions for safe operation of the IP and LP turbines.

Joyce Moore

From: <alan.holmes@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 3/29/02 8:39AM
Subject: Intermountain Torsional calcs

James, please pass this on to Jon Christensen (I do not have his E mail address).

We have converted the GE torsional inertia & stiffness data into an approx shaft model and performed a lumped mass calculation. The frequencies are virtually identical to the GE calcs (see below). Replacing the original HP rotor with the retrofit rotor (slightly reduced inertia & stiffness) changes the frequencies a little as shown :

GE calcs	Approx GE model	Retrofit	% change
14.0	14.9	14.1	-5.4
25.4	25.4	25.5	+0.4
33.1	33.4	33.3	-0.3
41.6	42.1	42.1	0
54.3	53.8	52.8	-1.8

Only the first frequency changes by more than 2 %.

GE qualify their calcs by saying "..... differences of greater than 15% may exist between measured and calculated values. For this reason the Steam Turbine-Generator Department disclaims all responsibility for the results derived from the data " !!

Regards
Alan

CONFIDENTIALITY:
This e-mail and any attachments are confidential and may be privileged. If you are not a named recipient, please notify the sender immediately and do not disclose the contents to another person, use it for any purpose, or store or copy the information in any medium.

CC: <phong-d@ipsc.com>, <barry.ingle@power.alstom.com>,

<adrian.bramley@power.alstom.com>

INTERMOUNTAIN UNITS 1 & 2

HP TURBINE RETROFIT

HP TURBINE SWALLOWING CAPACITY

UNIT 2

Performance Tests were carried out on Unit 2 by PGT in April 2002.

The installed ASME primary flow section, located downstream of the highest pressure feedwater heaters, was acid cleaned during the retrofit outage. On inspection, the internal surface was found to be "scarred and rough". In accordance with ASME guidelines, a value of ±2.5% was selected by PGT as the base uncertainty of the feedwater flow nozzles.

The corrected throttle flow (derived test flow corrected to design pressure and temperature) was determined to be as follows:

	Test 7	Test 8
PGT instrumentation	7,073,880 lb/h	7,077,720 lb/h
Station Instrumentation	6,931,726 lb/h	6,938,958 lb/h

This compared to the requirement of the throttle flow to be in the range 6,900,000 lb/h and 6,975,000 lb/h.

However, ALSTOM were surprised at this apparent high figure (although the ±2.5% uncertainty was noted), and in addition IPSC indicated that they were having to throttle more than they expected at a current (maximum) nominal load of 900 MW. IPSC estimated that the heat rate at 900 MW was approximately 0.1% worse than expected.

In order to better estimate the likely throttle flow (ie trying to reduce the uncertainty surrounding the feedwater flow measurement), ALSTOM carried out a calculation starting from the nominal heat balance diagram TS29247 at 6,900,000 lb/h throttle flow.
Using this as base, the effect of all the measured test conditions was determined - these included:

Throttle pressure and temperature
Reheat temperature
Condenser pressures
HP feedwater heater inlet and outlet temperatures
Steam flow to IP rotor cooling,
Steam flow to feedwater pump turbines.
Superheater spraywater flow

From this heat balance calculation, the following comparison is made:

INTERMOUNTAIN UNIT 2

		TS29247 →	TS29247 Corrected to Test conditions		TEST 8 APRIL 2002 PGT Test Measured	TEST 8 APRIL 2002 Station Instrumentation.
Throttle pressure	psia	2412.2	2389.8	←	2389.8	2398
Throttle temperature	°F	1000.0	993.2	←	993.2	997.5
Throttle flow	lb/h	6,900,000	6,849,904		7,039,852	6,904,554
Steam flow to IP rotor cooling	lb/h	17,115	18,987	←	18,987	
HP exhaust pressure	psia	629.0	630.9		628.2	624.5
IPSV pressure	psia	585.5	587.3		582.3	582.4
IPSV temperature	°F	1000.0	1006.7	←	1006.7	1007.5
IP exhaust pressure	psia	138.8	137.2		137.1	
Flow to FPT's (Total)	lb/h	276,367	282,021	←	282,021	
Condenser A pressure	"Hg	2.99	3.56	←	3.56	3.62
Condenser B pressure	"Hg	2.24	2.80	←	2.80	2.81
Condenser C pressure	"Hg	1.66	2.55	←	2.55	2.44
Condenser hotwell Temperature	°F	114.9	121.2		121.1	
DC outlet temperature	°F	123.5	128.7		128.5	
Heater 1 outlet temperature	°F	162.7	163.5			164.3
Heater 2 outlet temperature	°F	200.6	201.0			204.0
Heater 3 outlet temperature	°F	270.2	270.3			270.7
Heater 4 outlet temperature	°F	303.1	303.1			302.6
Deaerator outlet temperature	°F	350.3	350.3			348.7
Heater 6 inlet temperature	°F		355.7			355.3
Heater 6 outlet temperature	°F	404.0	403.8	←	403.8	
Heater 6 drain temperature	°F		364.9	←		364.9
Heater 7 outlet temperature	°F	488.6	487.6	←	487.6	
Heater 7 drain temperature	°F		412.5	←	412.5	
Heater 8 outlet temperature	°F	552.4	550.9	←	550.9	
Heater 8 drain temperature	°F		497.4	←	497.4	
Superheater spraywater flow	lb/h	0	108288	←	108288	66860
Reheater spraywater flow	lb/h	0	0	←	0	10527
Make up	%	1.0	0.0	←	0.0	
Generator output	MW	973186	969660		981954	982200
Heat rate	Btu/kWh	7683	7707		7886	7750

Note: ← = specified data in heat balance calculation. All other data is as-calculated.

From the tabulated data, it can be seen that the calculated throttle flow was 6,849,904 lb/h, but the generator output was only 969,660 kW compared to the test measurement of 981,954 kW. Additional throttle flow must therefore be present to generate this increased power.

Thus the additional throttle flow factor required to generate 981,954 kW is 981,954 / 969,660 = 1.0127.
This gives a required throttle flow of 1.0127 x 6,849,904 = 6,936,898 lb/h.

The actual test was conducted at main steam conditions different to nominal design, therefore a correction factor is required to derive what the throttle flow would have been with design main steam conditions:

$$\text{Flow correction factor} = \frac{2412.2}{2389.8} \times \frac{\sqrt{(993.2 + 460)}}{\sqrt{(1000 + 460)}} = 1.0070$$

Hence the **estimated** throttle flow for Intermountain Unit 2 at VWO under design main steam conditions is 6,936,898 x 1.0070 = **6,985,456 lb/h**.

This compares with the PGT corrected flow of 7,077,720 lb/h (ie estimated corrected flow is 1.3% lower than the PGT corrected flow derived from the flowmeter with a nominal uncertainty of ± 2.5%)

UNIT 1 PROPOSAL

Unit 1 fixed blades are about to be manufactured.

In discussions with IPSC it has been mutually understood that, as the units are limited for the forseeable future to a maximum load around 900 - 950 MW (including some throttling reserve for rapid load pickup capability), it is desirable for Unit 1 capacity to be reduced compared to that of the installed Unit 2.
This reduction is agreed to be nominally 1% of throttle flow, and will be achieved by modifying the fixed blade throat openings of stage 1 only.
However, to maintain the final feedwater temperature, the fixed blade following the HP steam path extraction has also to be modified. Without this additional modification, the final feedwater temperature would reduce by approximately 1°F.

With these changes to HP stage 1 and 6 fixed blades, the expected throttle flow of Unit 1 (assuming similar as-made nozzle sizes to Unit 2) would be 6,985,456 x 0.99 = 6,915,600 lb/h.

From: <bill.eisma@power.alstom.com>
To: <jim-n@ipsc.com>
Date: 8/2/02 5:45AM
Subject: Operation with heaters out of service

James,

Following your request of 7/19/02 and confirmation of 8/10/02 we have completed the study operation of the retrofitted unit with heaters out of operation. The results are attached.

Please do not hesitate to call us if you need additional explanations or clarification regarding these results.

Sincerely,

Bill Eisma

(See attached file: Intermountain- Isolation of HP heaters Memo.pdf)(See attached file: heaters.PDF)

CC: <phong-d@ipsc.com>

From: <phill.kearney@power.alstom.com>
To: "James Nelson" <jim-n@ipsc.com>
Date: 6/7/01 2:40AM
Subject: Re: A couple more issues from Intermountain

James,
We were not led astray by choice of steam tables. We realised that the data you supplied was based on 1967 tables and modelled it as such before switching to 1997 tables for the purpose of the retrofit design.

A first stage pressure tap is necessary for a nozzle control/partial arc admission machine, and your existing thermal kit includes a curve of first stage pressure against throttle flow.

For a throttle control/full arc admission machine as the retrofitted machine will be, the equivalent measurement is the cylinder inlet pressure/after valve pressure, where you will have a pressure tap in order to determine the valve pressure drop. We will supply a new curve of cylinder inlet pressure against throttle flow for the revised thermal kit.
Phill.

"James Nelson" <jim-n@ipsc.com> on 06/06/2001 20:56:35

To: Alan HOLMES/LTR/STG/PGD/GECALSTHOM@GA, Phil HENNESSY/LTR/STG/PGD/GECALSTHOM@GA, Phill KEARNEY/MEC/PGD/PGD/GECALSTHOM@GA
cc:
Subject: A couple more issues from Intermountain

In another chat with our performance group today I realized that the numbers we originally provided to you for calculation of our heat balance we based on 1967 steam table data. Not the 1997 steam table data that is quoted within the specification as being the basis for the Alstom design. Please double the application of the data which we sent to you to ensure that we did not lead you astray in the data we provided.

Also, There is some level of concern here that Alstom is not intending to provide pressure taps within the steam path where we currently have them now (1st stage). Could someone please comment on the various aspects of relocation of these taps.(i.e. why 1st stage pressure is not advisable) The turbine performance group we work with named, PEPSE, is telling us that the retrofits they have worked on, retain the 1st stage pressure taps. Any input would be appreciated.

Please let me know, as soon as you reasonably can, of the anticipated impact of the steam table revision issue.

Regards

CC: <phil.hennessy@power.alstom.com>, <alan.holmes@power.alstom.com>, <robert.brown@power.alstom.com>, <richard.plant@power.alstom.com>, <adrian.bramley@power.alstom.com>

From: James Nelson
To: bill.eisma@power.alstom.com
Date: 8/1/02 10:59AM
Subject: Re: Delta retrofitted units 1+2 , Operation with Heaters out of service.

Bill,
The original requisition was created with the expectation that there would be these types of small but vital side studies. Please forward the results of the study to me as soon as possible and proceed with billing us under the same purhcase order as the HP retrofit.
Regards,
James

>>> <bill.eisma@power.alstom.com> 07/31/02 12:55PM >>>
James,

In your E-mail of 7/19/02 you requested our engineering department to investigate the affect on the operation of the retrofitted HP units with heaters out of operation.

To complete this study including various load calculations and output tables for the alternates we have to invest some additional engineering time. The cost for this extra work amounts to $4,250.00

Would you please approve this additional expenditure so I can request the completed study for forwarding to you.

Thanks,

Bill Eisma

CC: Phong Do

From: James Nelson
To: adrian.bramley@power.alstom.com
Date: 5/21/01 3:50PM
Subject: Re: Lost and Found

Thank you Adrian. I realized I had left it in the conference room when I was somewhere over the Canary Islands. Also, many thanks for a delightful and productive visit to the UK and to Alstom. Also thanks to Lisa for being such a kind sport about the whole thing.

Thank you for the e-mail regarding the performance issues etc. I double checked with the performance group and they confirmed that they would indeed request heat balance diagrams at 25%, 50%, 75%, 100% and VWO in addition to the 100% with reduced pressure.

It might be well for us to talk tomorrow.
James

>>> <adrian.bramley@power.alstom.com> 05/21/01 08:22AM >>>

James,

We have found your folder - the one with Connah's Quay photo's in it.

I will Fed - Ex it to you.

Best regards,

Adrian.

From: <alan.holmes@power.alstom.com>
To: <PHONG-D@ipsc.com>
Date: 3/1/02 10:01AM
Subject: Re: Turbine-Generator SMF Relay Protection

The retrofit HP rotor is 6% lighter than the existing GE rotor (mostly due to the smaller hub diameter) and the blades, although weighing nearly the same as the original ones in total, act at a smaller radius. We estimate that this leads to approximately a 14% reduction in HP rotor inertia..
Estimated inertias
Original GE rotor 1435 Kg.m(superscript: 2)
Retrofit rotor 1229 Kg m(superscript: 2)

However the HP rotor inertia represents only a small proportion of the total shaftline inertia which we estimate to be something in excess of 20,000 Kg.m(superscript: 2)

So the change in total shaftline inertia is 200 in 20,000 ie 1%.

Torsional natural frequencies are usually only an issue on LP retrofits.

My fax number is 44 1788 531775

Regards
Alan

"Phong Do" <PHONG-D@ipsc.com> on 27/02/2002 22:09:29

To: <adrian.bramley@power.alstom.com>, <Alan.holmes@power.alstom.com>
cc: "James Nelson" <JIM-N@ipsc.com>, "Jon Christensen" <JON-C@ipsc.com>, <barry.ingle@power.alstom.com>, <bill.eisma@power.alstom.com>

Subject: Turbine-Generator SMF Relay Protection

Alan, Adrian,

Please response to the below comment from our electrical engineer. Thanks.

"The turbine-generator protection circuits include subsynchronous machine frequency (SMF) relays. These relays are designed to prevent torsional stress damage to the turbine-generator. Fatigue loss of life or failure can occur when a subsynchronous resonance condition exists between the natural mechanical frequency of the turbine-generator and the natural electrical frequency of the power system. Because our power system includes a converter station these relays are required for safe operation of the turbine-generators.

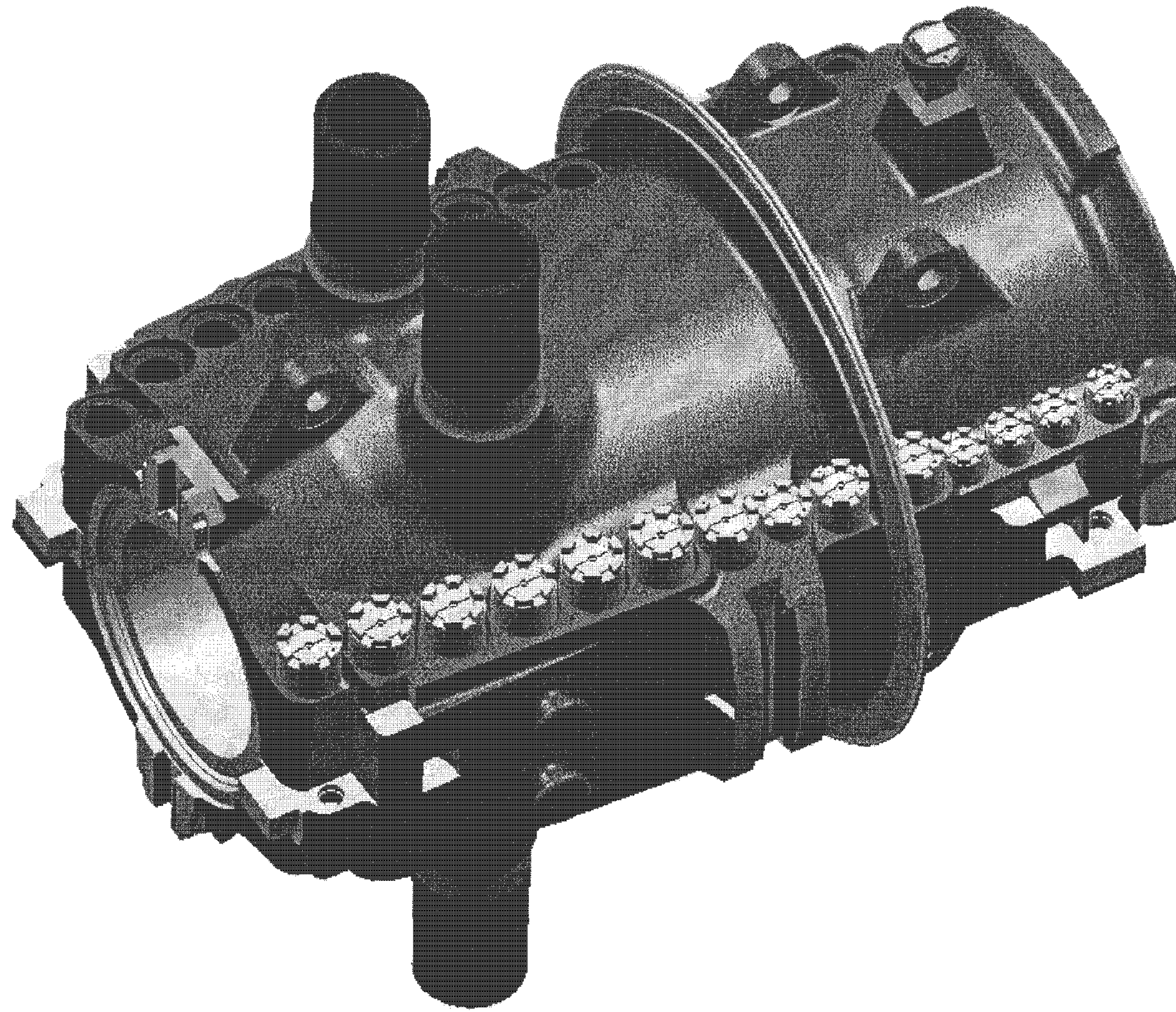
IP7008893

The settings for our relays are based on a turbine-generator torsional vibration mathematical model. This model required the polar moment of inertia, stiffness, material and dimensions of the existing General Electric HP turbine.

Has Alstom evaluated what effect, if any, the replacement HP turbine will have on the settings for the existing SMF relays? Do they have any experience in modeling torsional vibration or in developing settings for SMF relays?"

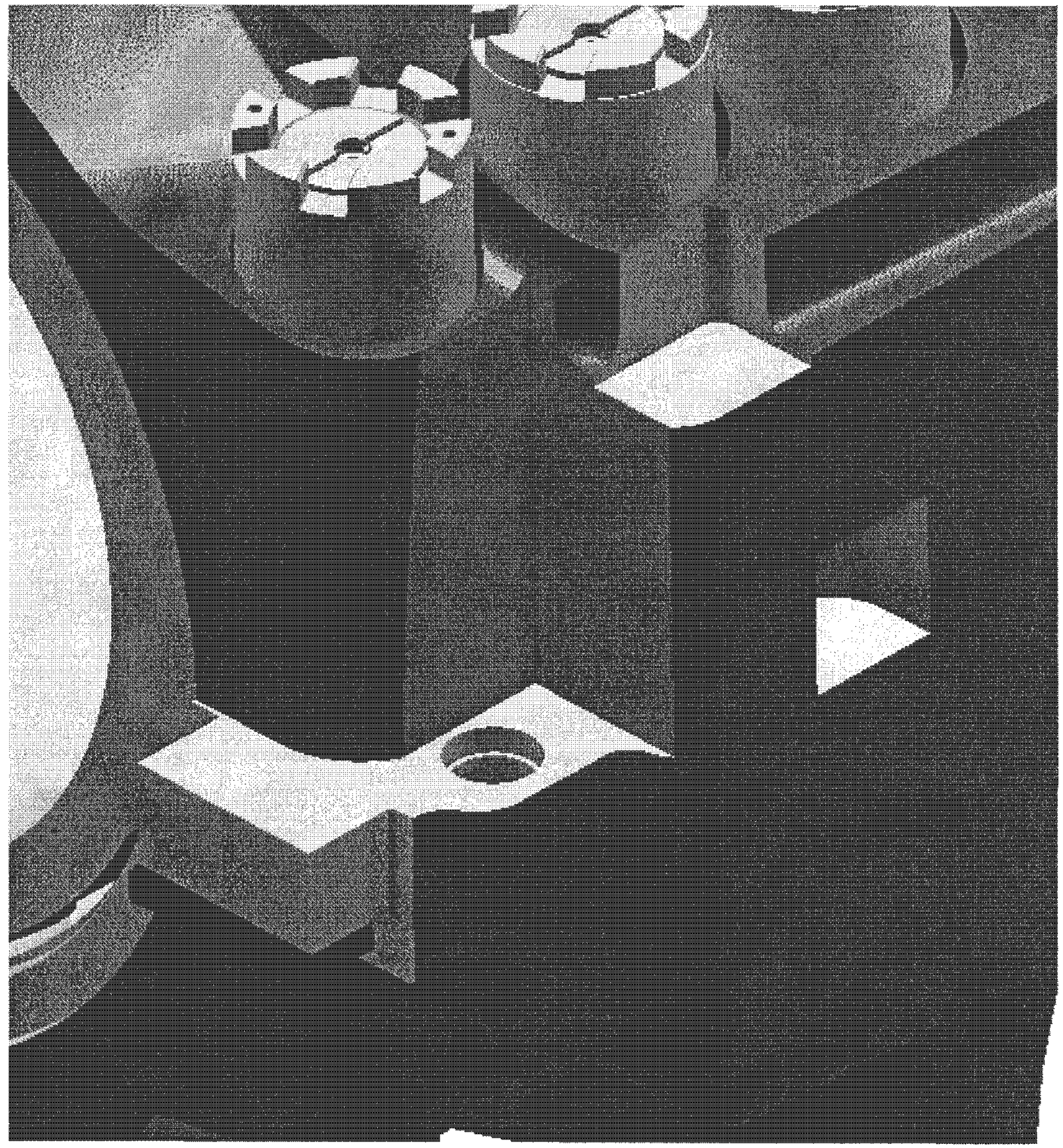
INTERMOUNTAIN HP INNER CASING MODULE

Inner casing module with casing guides and supports



INTERMOUNTAIN HP INNER CASING MODULE

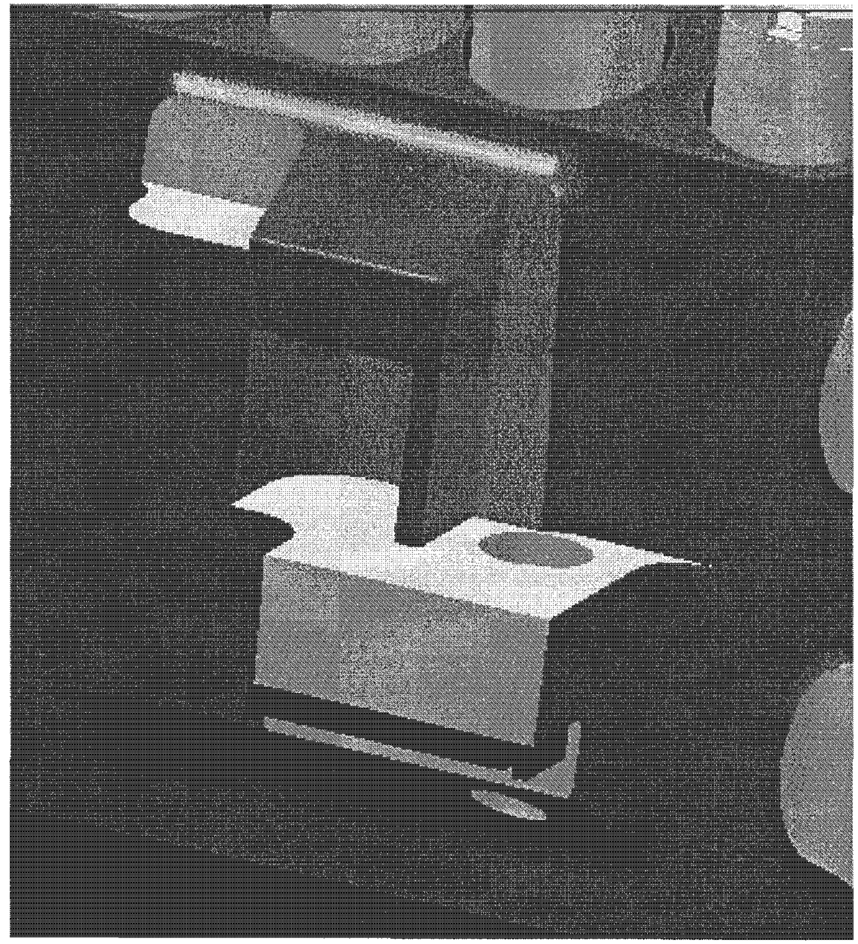
Inner casing rear support
palm, flange
separation jack
pocket and casing
bottom half holding
down bolt location



IP7008896

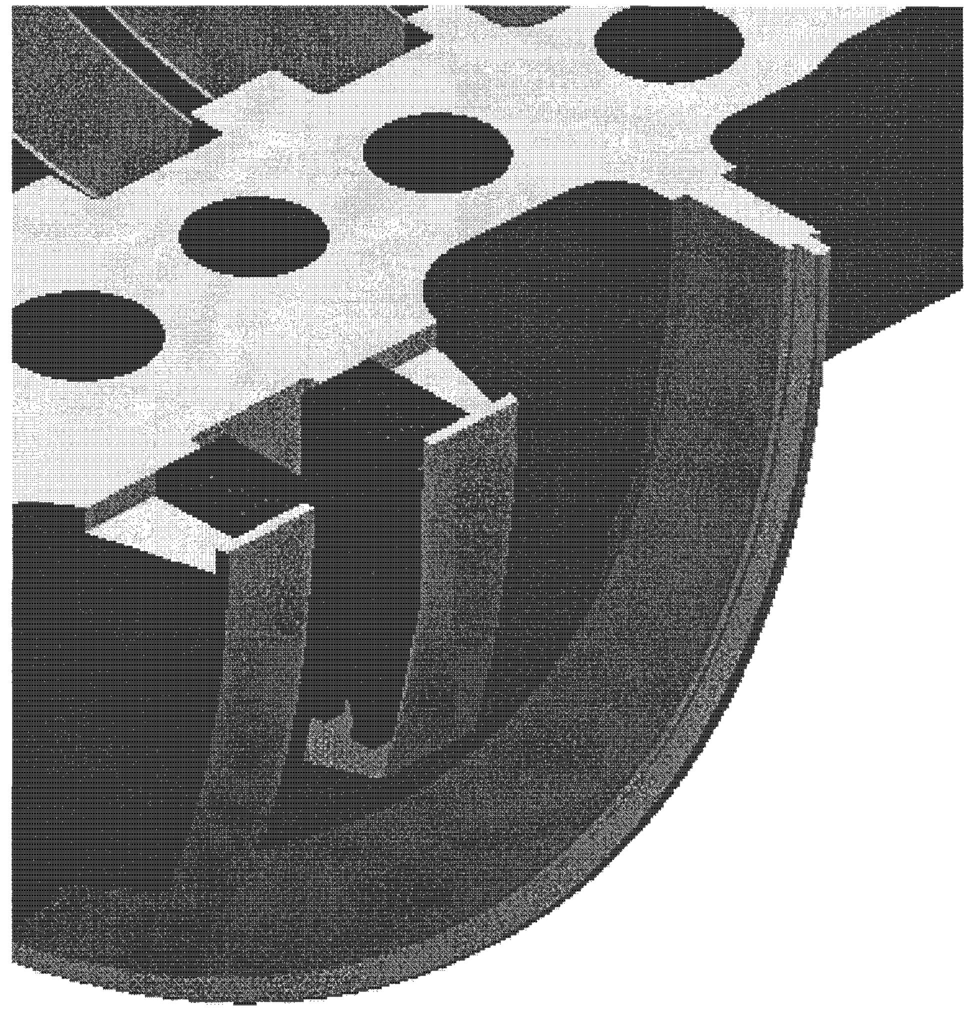
INTERMOUNTAIN HP INNER CASING MODULE

Inner casing front support palm, flange separation jack pocket and casing bottom half holding down bolt location



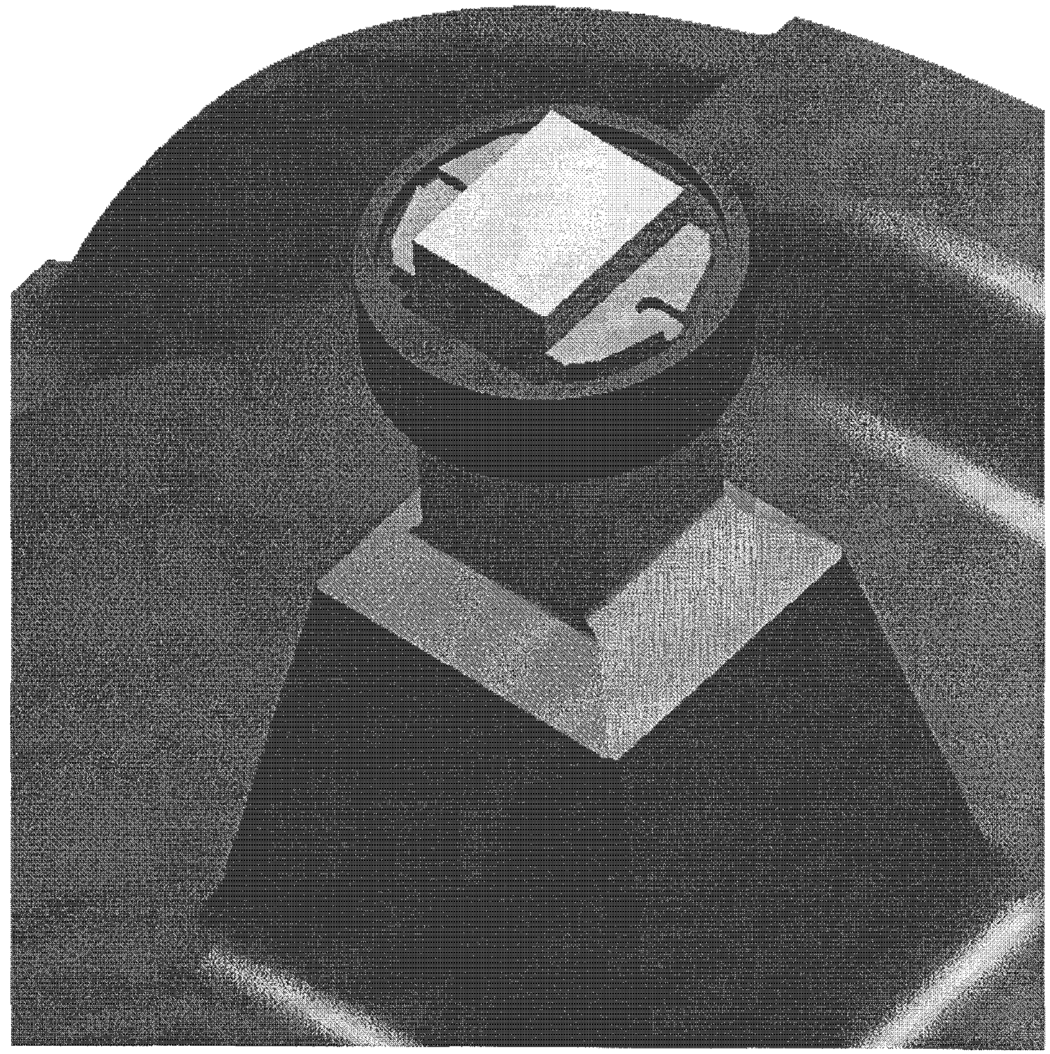
INTERMOUNTAIN HP INNER CASING MODULE

Inner casing axial packers (8 off, 4 top half and 4 bottom) and integral machined baffle



INTERMOUNTAIN HP INNER CASING MODULE

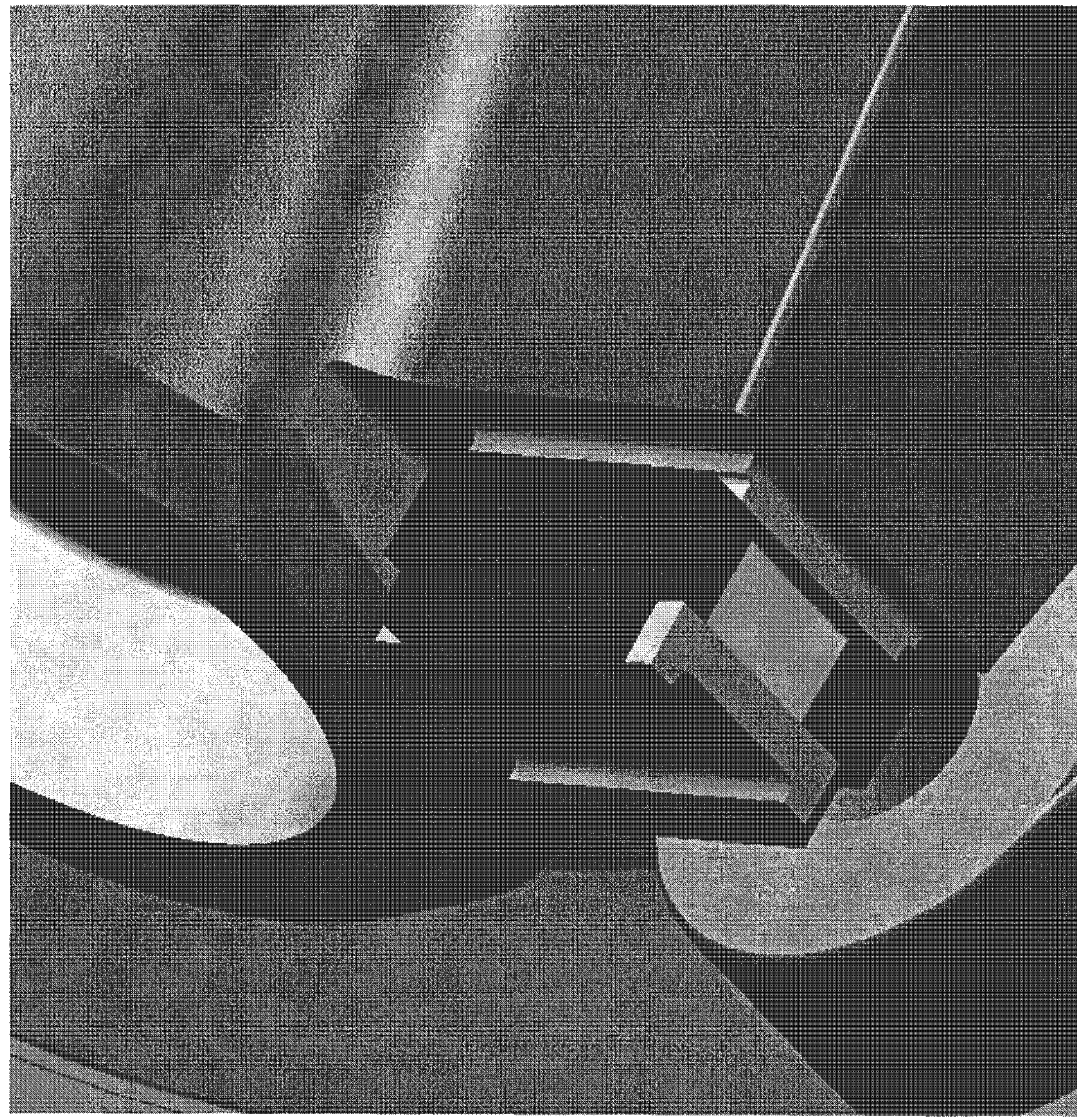
Inner casing top front transverse packers and outer casing insert



IP7008899

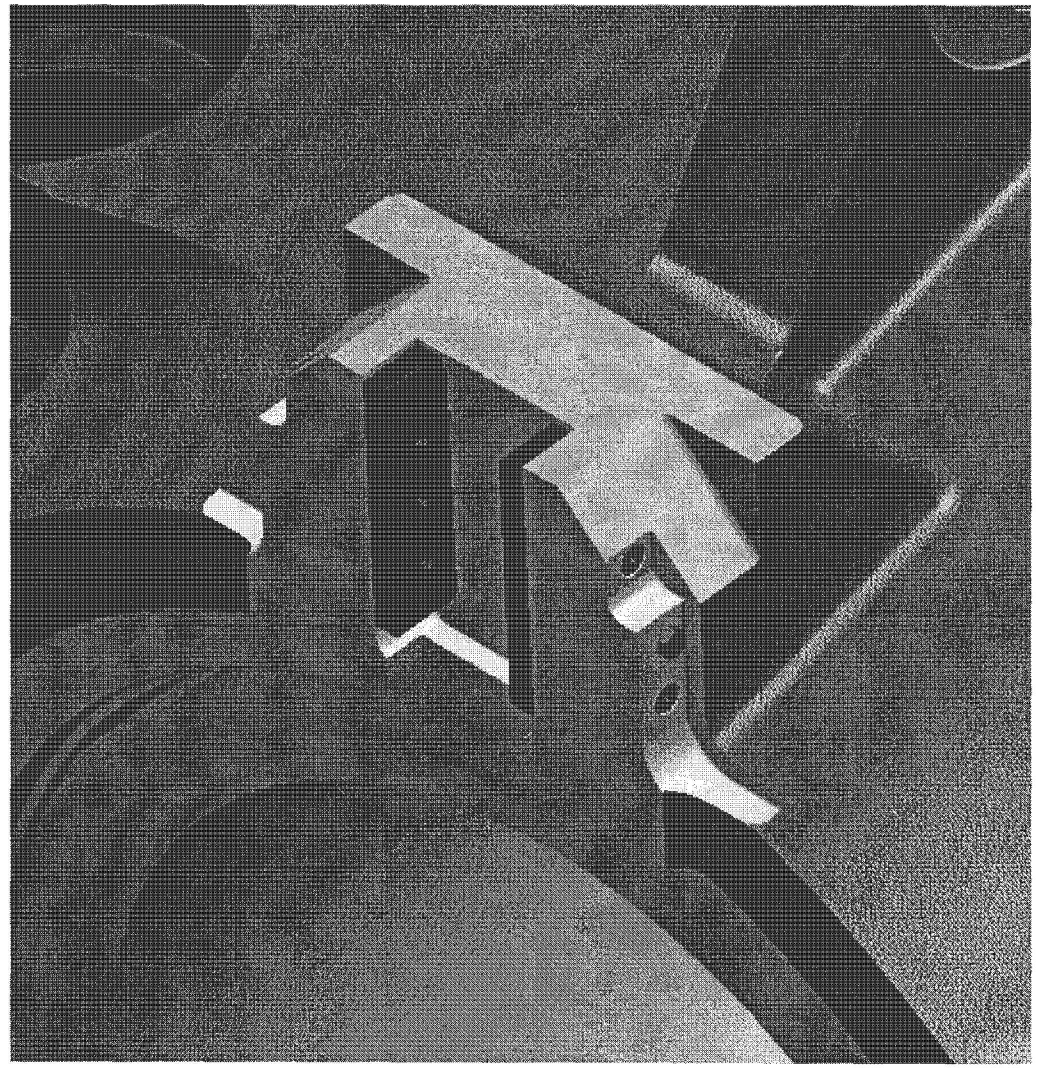
INTERMOUNTAIN HP INNER CASING MODULE

Inner casing bottom front transverse packers and heater connection



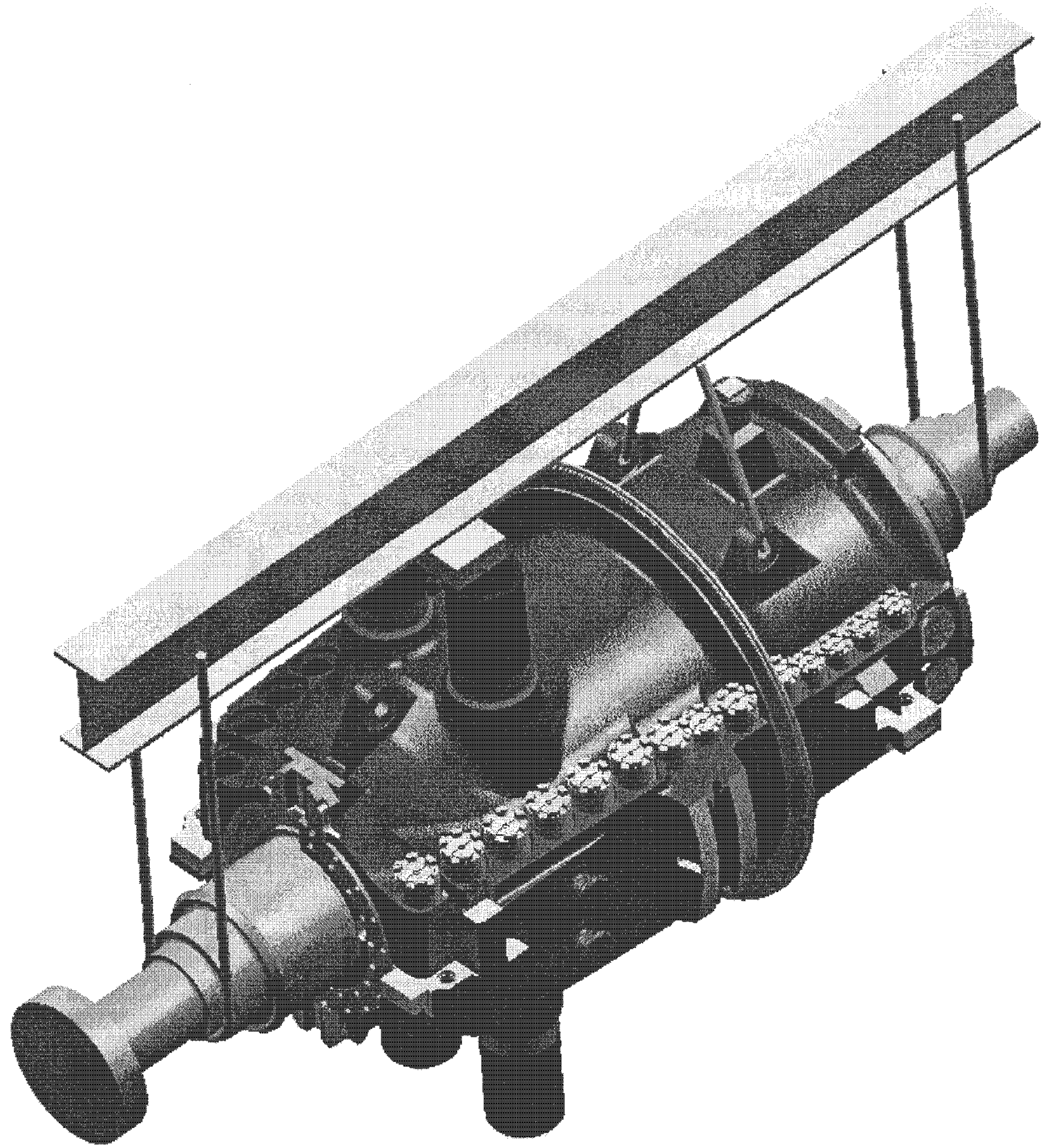
INTERMOUNTAIN HP INNER CASING MODULE

Inner casing top and bottom rear transverse packers



INTERMOUNTAIN HP INNER CASING MODULE

Lifting beam
carrying rotor
and inner casing
module

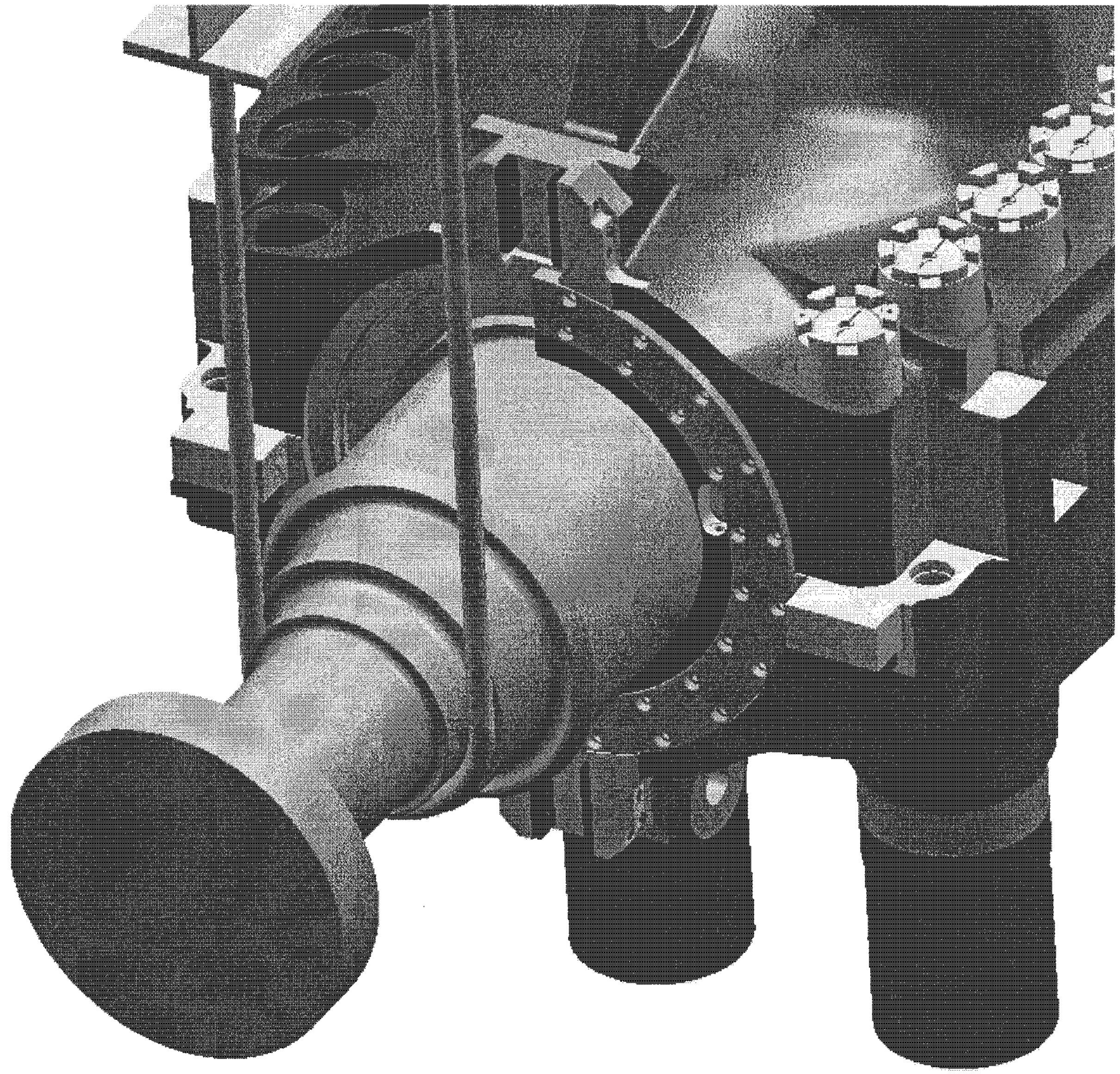


IP7008902

INTERMOUNTAIN HP INNER CASING MODULE

Lower casing module with bottom half transportation bracket on for initial build.

Use rotor as mandrel and determine packer sizes.

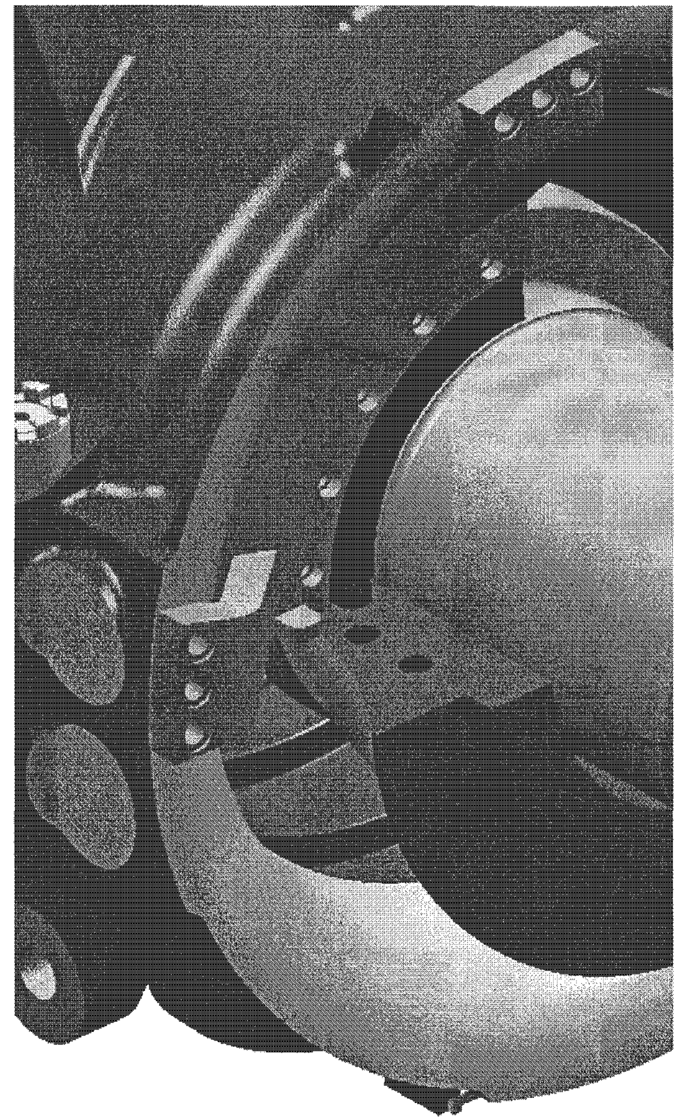


IP7008903

INTERMOUNTAIN HP INNER CASING MODULE

Lower casing module for final assembly with bottom half exhaust gland attached to beam.

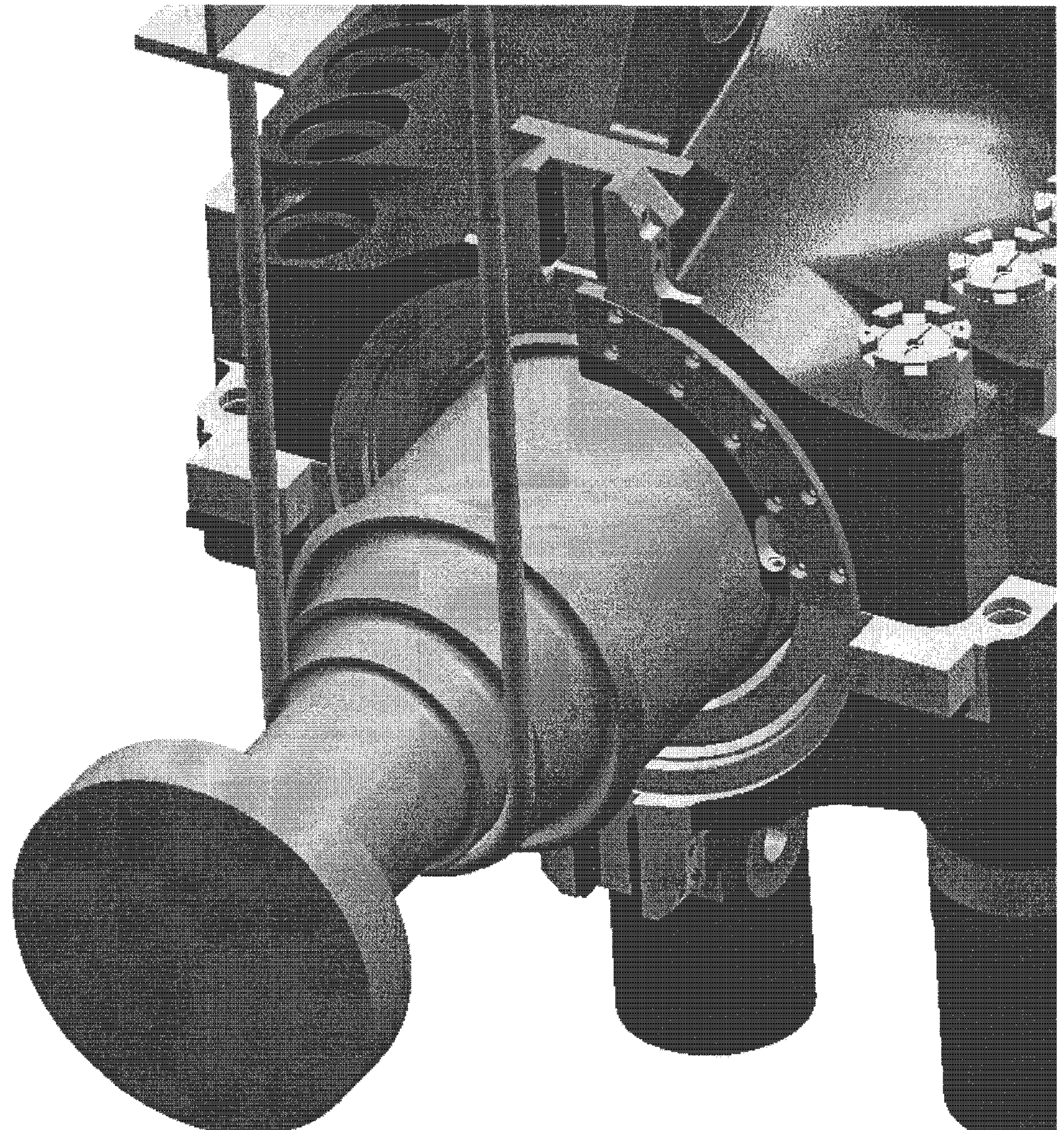
Bottom half transportation bracket removed.



IP7008904

INTERMOUNTAIN HP INNER CASING MODULE

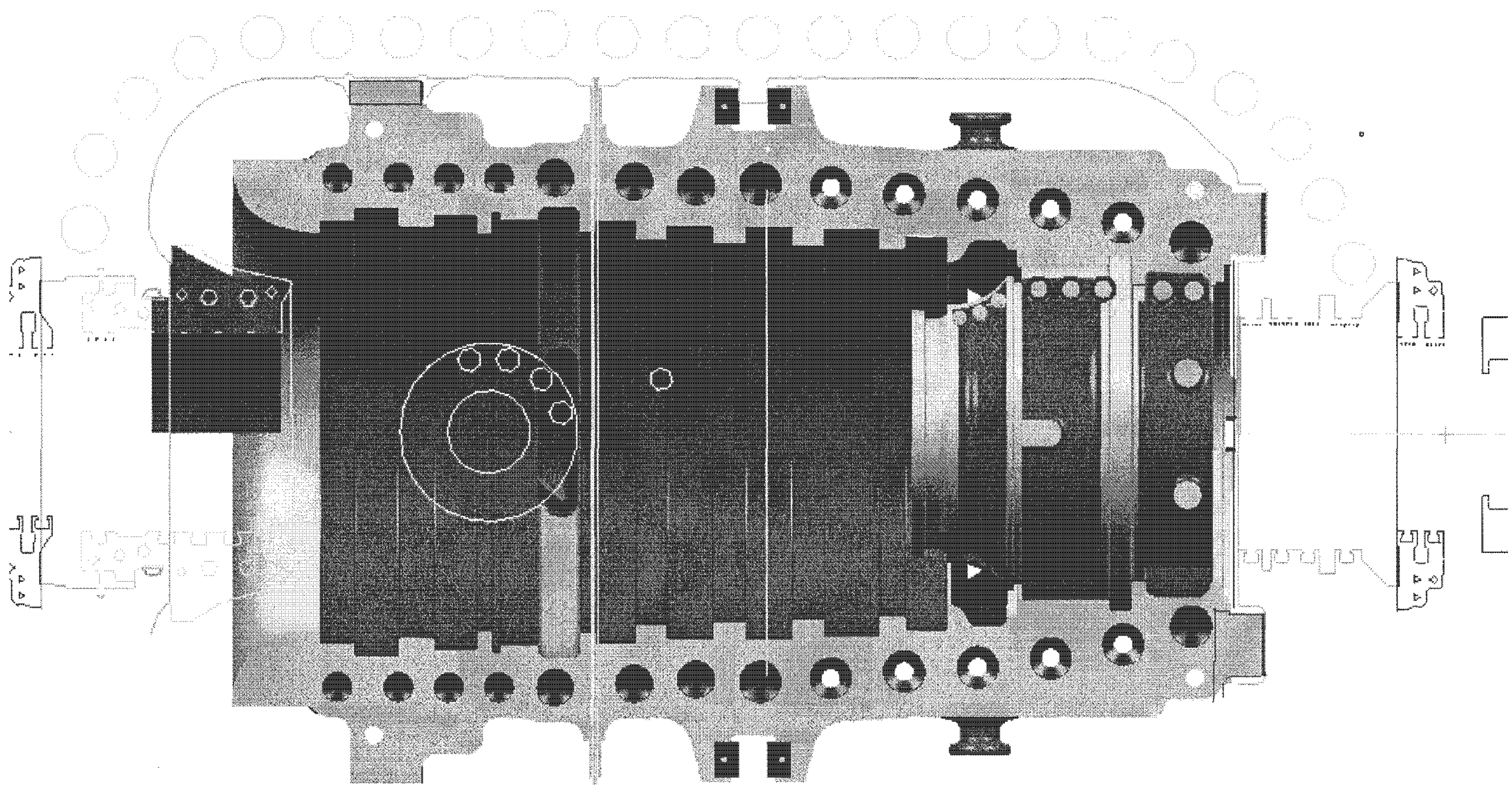
Lower casing module for final assembly with bottom half transportation bracket removed.



IP7008905

INTERMOUNTAIN HP INNER CASING MODULE

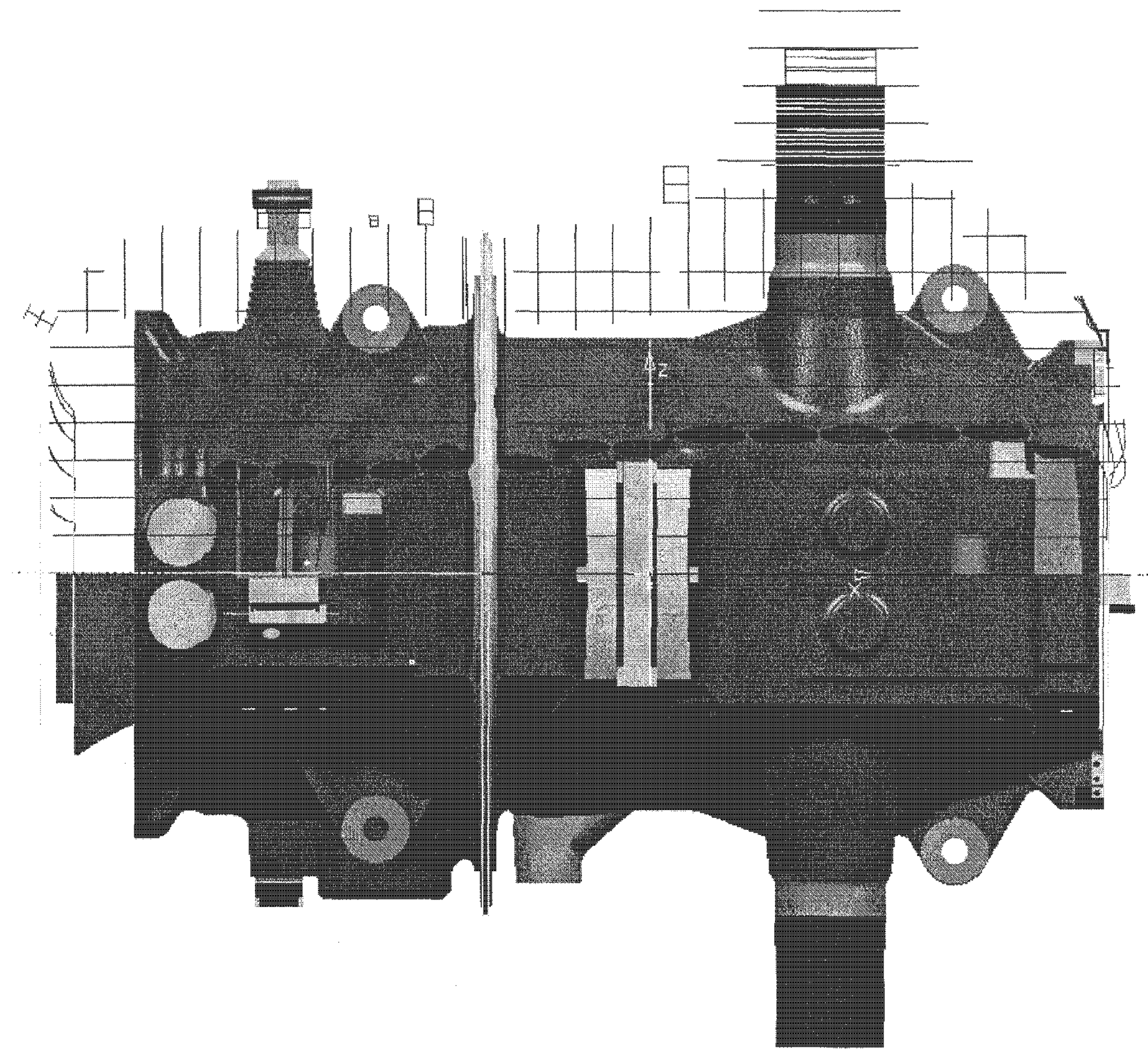
Inner casing, inlet gland and exhaust gland with Intermountain Farodata



IP7008906

INTERMOUNTAIN HP INNER CASING MODULE

Inner casing and packers with Intermountain top half outer casing Farodata



IP7008907